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CIVIL ENGINEERING

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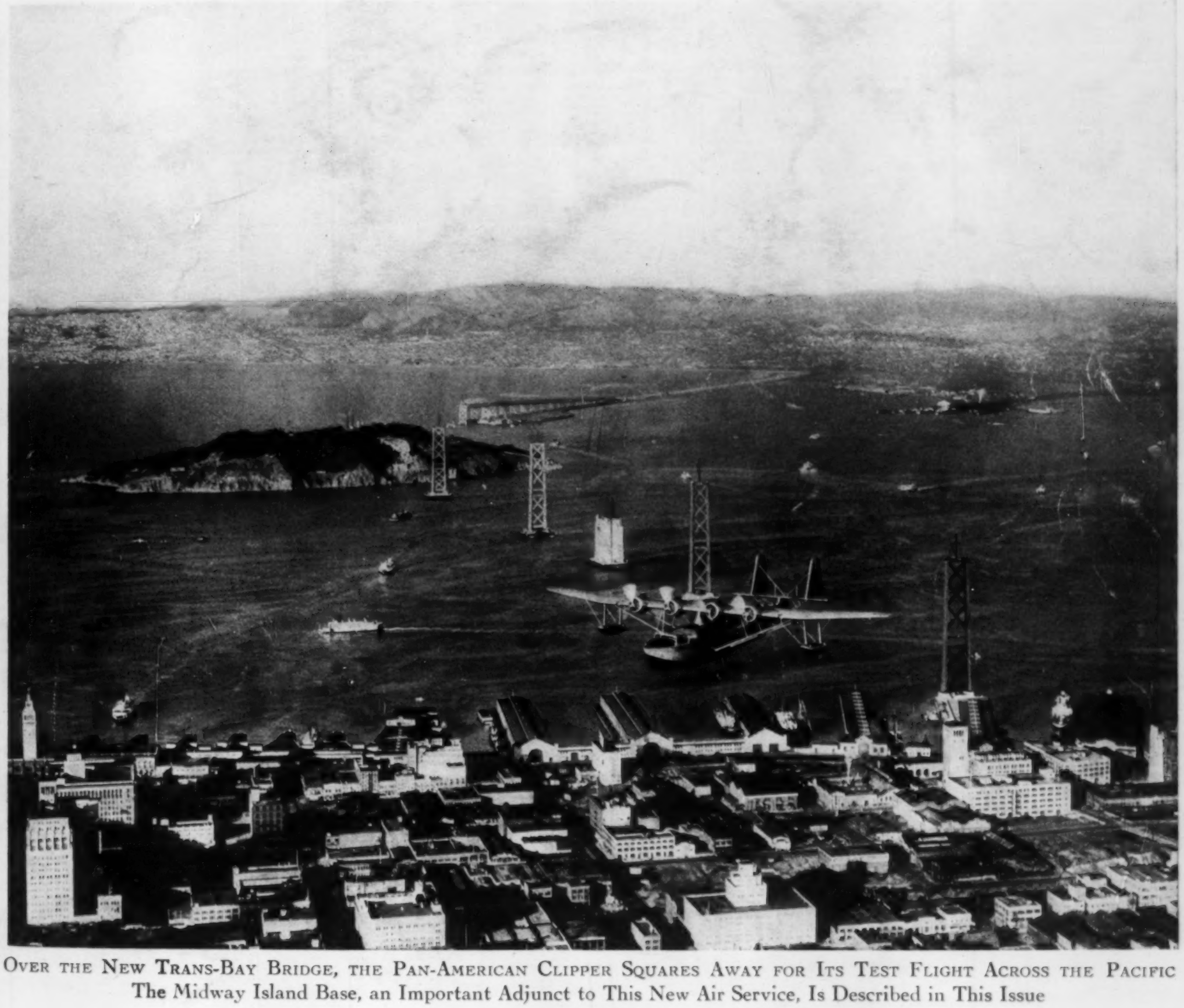

Over the New Trans-Bay Bridge, the Pan-American Clipper Squares Away for Its Test Flight Across the Pacific
The Midway Island Base, an Important Adjunct to This New Air Service, Is Described in This Issue

Volume 6 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 1*

JANUARY 1936

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Among Our Writers

Edward L. Winslow, Jr., served as assistant engineer of design and construction for the Mahoning Valley Sanitary District previous to becoming assistant chief of dam design for the Muskingum project. He is now in full charge of dam design.

C. C. Chambers has had 20 years' experience in flood control and other hydraulic work, including the design and construction of dams and reservoirs. He has served as chief engineer for the Muskingum Conservancy District since it was created in 1933.

T. T. Knappen, during the 6 years immediately preceding his appointment as chief of the engineering division, on the Muskingum project, served as Cairo area engineer in charge of 175 miles of flood control work on the Mississippi.

A. L. Alin has designed and built dams both in this country and abroad. From 1930 to 1933 he served as hydraulic engineer with the U. S. Corps of Engineers, principally at Portland, Ore.

George E. Barnes for the past 12 years has specialized in hydraulic and sanitary engineering work, as a designing engineer on a number of important projects, as a consulting engineer, and as a teacher.

J. G. Jobes graduated in civil engineering at the University of Michigan in 1929. Previous to his work (now completed) as associate engineer and chief of the hydraulic models subsection at Zanesville, he served as chief of a hydraulic research group, U. S. Waterways Experiment Station, Vicksburg, Miss.

Gilbert H. Friend has had 32 years of experience in railroad work, including both construction and maintenance. He was in charge of the construction of the McComas Street terminal at Baltimore, Md., for the Western Maryland Railway from 1925 to 1929.

Charles E. McKee graduated from the U. S. Military Academy in 1918. He has served with the Ohio State Highway Department since 1925 in various capacities, including those of division engineer and chief engineer of maintenance.

Oliver W. Gatchell was educated at the University of Cincinnati. Previous to May 1934, he spent 10 years as transmission-line engineer with the Electric Bond and Share Company on line design and construction.

E. McD. Moore, during his 35 years of experience, has specialized in investigating foundations for and designing earth dams, including work on the Deerfield River dams, the Somerset (Vt.) Dam, and the Saluda (S.C.) Dam.

R. R. Philippe holds a bachelor's degree in civil engineering from the Massachusetts Institute of Technology. For the past 4 years he has been engaged in soil mechanics investigations and is now chief of the soils laboratory at Zanesville.

Herbert M. Knight, before becoming engineer for the New York office of the Maryland Casualty Company in 1922, had long experience in construction work, from division engineer for municipalities to contracting engineer and contractor.

Albert A. Mittag served on highway work in Salvador and Colombia and with the Quartermaster Corps, U. S. Army, in the Canal Zone and at Langley Field, Va., previous to being placed in charge of construction at Midway Island for the Pan-American Airways, Inc.

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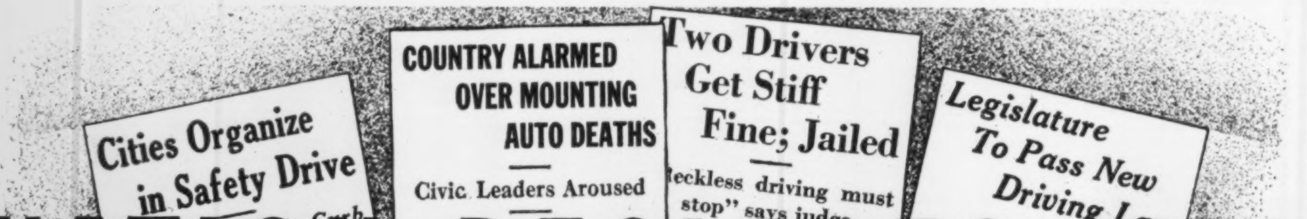

Cities Organize in Safety Drive

COUNTRY ALARMED OVER MOUNTING AUTO DEATHS

Civic Leaders Aroused

Two Drivers Get Stiff Fine; Jailed

"Reckless driving must stop" says judge

Legislature To Pass New Driving Law

NATION DECLARES WAR ON ACCIDENT TOLL

White Concrete Markers

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CIVIL ENGINEERING

January 1936

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Number 1

The Muskingum Flood Control Work

A Symposium on the $34,500,000 Flood-Control and Water-Conservation Project in Eastern Ohio

Draining an area of 6,850 sq miles north of Zanesville, Ohio, the Muskingum River system creates conditions that add measurably to floods in the Ohio River. This consideration was a factor in the $22,590,000 given by Public Works Administration for the construction of 14 main flood-control and water-conservation reservoirs in the basin, where floods have already done a great deal of damage to towns, railroads, highways, and other properties. The Muskingum Watershed Conservancy District, organized under the Ohio Conservancy Act from local communities to be benefited by the flood control and conservation work, will contribute $8,000,000, and the state $4,000,000. The U. S. Corps of Engineers prepared the plans and is in charge of construction. On October 4, 1935, at the Zanesville regional meeting, attended by a number of the Society's Local Sections, engineers in charge of various phases of the work presented ten papers, which are here abstracted for the information of members.

Although the article by Mr. Winslow, giving a general description of the dams, was not presented first at the meeting, it leads the symposium in order to acquaint the reader at the outset with the more general aspects of the work. Next comes the article by Mr. Chambers, sketching in the historical background of the project and reviewing the activities of the Conservancy District.

In his paper on the general design of the project, Mr. Knappen presents the principles and methods used in determining just what the location, size, and general characteristics of each reservoir should be to give the best return for the expenditure of the funds available. The reconstruction of runoff hydrographs for the great storm of 1913 and the development of others for the "official plan storm" are of interest.

Outlining the principles followed in the design of rolled-fill dams for pervious and for impervious foundations, Mr. Alin tells the reasons for the wide variety of outlets and spillways employed. Special attention is given to the only concrete dam, at Dover.

Of special interest to the student of models is an account of valuable experiments on hydraulic models made by Professor Barnes and Mr. Jobes in connection with the project. This material is a brief abstract from a more comprehensive paper.

The problems met with in relocating the tracks of railroad lines to be affected by the future pools, together with their solutions, are presented in an interesting manner by Mr. Friend. Mr. McKee treats in a similar way the subject of relocating 150 miles of state highways and county and township roads which were considered necessary or important enough to be made permanent. The public utility changes necessitated by the work, as described by Mr. Gatchell, will involve 78 miles of oil and gas lines and 272 miles of aerial lines, including telephone, telegraph, and high- and low-voltage electric circuits.

In his article on the construction and control of earth dams, Mr. Moore explains how construction was adjusted to meet the availability of local materials. With proper precautions, shale has been successfully used for impervious embankments.

The concluding article, by Mr. Philippe, declares that the same study of structural strength and stresses should be accorded the soil as is given other materials of construction. The principles of soil mechanics have been carefully applied to the design of the dams.

General Description of Project Works

By Edward L. Winslow, Jr.
Associate Member American Society of Civil Engineers
Associate Engineer and Assistant Chief, Dam and Reservoir Section, U. S. Engineer Office, Zanesville, Ohio

The official plan for the Muskingum Watershed Conservancy District contemplates the development of 14 reservoirs for the control of flood waters in the Muskingum basin. The project consists primarily of the construction of 14 dams and appurtenant structures; the relocation of sections of 9 railroads and 150 miles of highways; the construction of 11 levees with appurtenant drainage and pumping facilities for the protection of towns and industries in the watershed; and the relocation of 10 gas lines, 4 transcontinental oil lines, 11 power lines, and 20 telegraph and telephone lines. In addition to the public utilities relocated by contract, some sixty other removals and relocations have been settled by agreement, and the construction work has been carried on by the parent company or by government day labor.

The total estimated cost of the project is $34,590,000, of which $22,590,000 is to be furnished by the United States from Public Works Administration funds for construction purposes; $8,000,000 by the Muskingum Watershed Conservancy; District for the purchase of lands, easements, and rights of way; and $4,000,000 by the State of Ohio for the relocation of highways and roads. A brief description of each of the reservoirs is given in Table I.

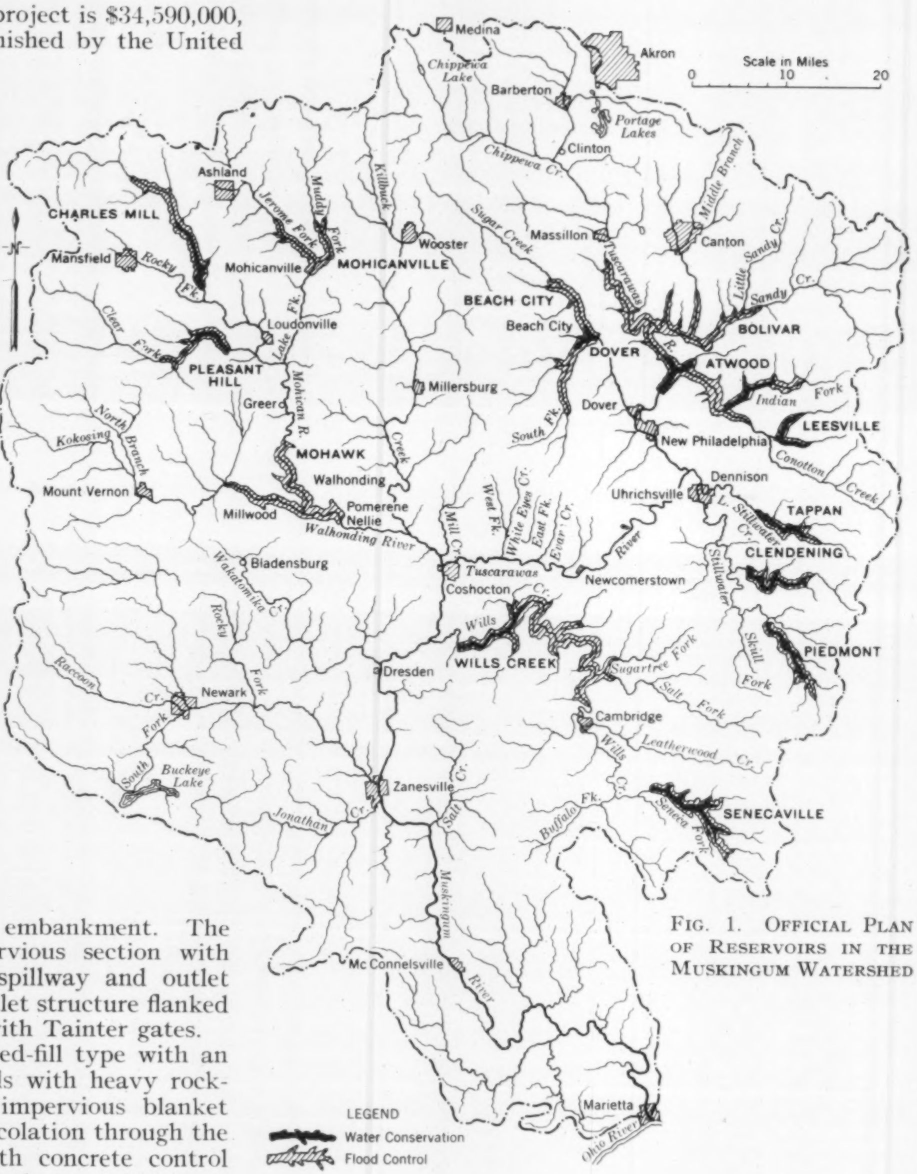

Medina
Akron
Scale in Miles
0
10
20
Chippewa Lake
Barberton
Portage Lakes
Clinton
Chippewa Cr.
Ashland
Middle Branch
CHARLES MILL
Muddy Fork
Jerome Fork
Killbuck
Wooster
Sugar Creek
Massillon
Canton
N
Mansfield
Rocky Fk.
Mohicanville
MOHICANVILLE
Tuscarawas R.
Little Sandy Cr.
Sandy Cr.
BEACH CITY
Beach City
Clear Fork
Loudonville
Lake Fk.
BOLIVAR
DOVER
ATWOOD
PLEASANT HILL
Mohican R.
Indian Fork
Millersburg
Greer
LEESVILLE
North Branch
Kokosing
Dover
South Fk.
Conotton Creek
MOHAWK
Creek
New Philadelphia
Walhonding
Mount Vernon
Dennison
Pomerene
Nellie
Uhrichsville
TAPPAN
Millwood
Walhonding River
Mill Cr.
West Fk.
White Eyes Cr.
East Fk.
Evans Cr.
River
L. Stillwater Cr.
CLENDENING
Bladensburg
Wakatomika Cr.
Tuscarawas
Coshocton
Newcomerstown
Stillwater
Rocky Fork
Wills Cr.
WILLS CREEK
Sugartree Fork
Skull Fork
PIEDMONT
Raccoon Cr.
Dresden
Newark
Salt Fork
Cambridge
Leatherwood Cr.
South Fork
Buckeye Lake
Wills Cr.
Zanesville
Salt Cr.
Buffalo Fk.
SENECAVILLE
Seneca Fork
Jonathan Cr.
Muskingum River
Mc Connelsville
Marietta
Ohio River
LEGEND
Water Conservation
Flood Control

FIG. 1. OFFICIAL PLAN OF RESERVOIRS IN THE MUSKINGUM WATERSHED

CHARACTERISTICS OF THE VARIOUS DAMS

The Wills Creek Dam is of the rolled-fill earth-embankment type, consisting of a central impervious core grading to pervious material at the outer slopes, which are of dump rock fill. The average upstream and downstream slopes are about 1 on 3. The spillway is of the open-cut type with a concrete lining at the control section. The outlet works consist of a concrete intake housing six caterpillar-type gates, two horseshoe-shaped cut-and-cover conduits, and a concrete-lined stilling basin.

The Senecaville Dam is interesting in that it consists of a central combined spillway and outlet structure cut through a rock terrace, flanked on each side by an embankment. The embankments consist of an impervious section with heavy rock toes. The combined spillway and outlet structure is made up of a central outlet structure flanked by two concrete overflow sections with Tainter gates.

The Mohawk Dam is of the rolled-fill type with an impervious core, and pervious shells with heavy rock-filled outer shells. An upstream impervious blanket protects the dam from excessive percolation through the foundation. A saddle spillway with concrete control weir is located in a natural saddle at the east abutment. The outlet work consist of a concrete intake housing six caterpillar-type gates, two concrete-lined tunnels, and a concrete-lined stilling basin.

The Pleasant Hill Dam is of interest in that the reservoir it creates will form a part of the Mohican State Park. The dam is of the rolled-fill type with an impervious core, a pervious shell, and rock fill on the upstream slopes. The outlet structure is a combined spillway and outlet of the morning-glory type. A concrete-lined tunnel and stilling basin form a part of the outlet works.

The Charles Mill Dam consists of a main embankment with spillway and outlet works and two dikes. The embankment and the dikes are made up of an impervious core and a pervious shell. A combined spillway and

TABLE I. PRINCIPAL DATA ON MUSKINGUM WATERSHED RESERVOIRS

RESERVOIR	STREAM	DRAINAGE AREA (Sq Miles)	CAPACITY (ACRE-FEET)		FLOOD CAPACITY (Inches)	ESTIMATED COST
			Flood Control	Conservation		
Wills Creek	Wills Creek	844	190,000	6,000	4.9	$ 1,659,613
Senecaville	Seneca Fork	121	45,000	43,500	7.0	496,965
Mohawk	Walhonding River	1,501	285,000	0	6.5	3,451,986
Pleasant Hill	Clear Fork	199	74,200	13,500	7.0	1,237,969
Charles Mill	Black Fork	216	80,600	7,400	7.0	921,389
Mohicanville	Lake Fork	269	102,000	0	7.0	538,554
Tappan	Little Stillwater Creek	71	26,500	35,100	7.0	725,036
Clendening	Brushy Fork	70	26,100	27,900	7.0	425,862
Piedmont	Stillwater Creek	84	31,400	33,600	7.0	607,646
Beach City	Sugar Creek	300	70,000	1,700	4.4	2,541,423
Dover	Tuscawaras River	1,397	202,000	1,000	5.0	4,839,299
Bolivar	Sandy Creek	502	149,600	0	5.6	3,510,480
Atwood	Indian Fork	70	26,100	23,500	7.0	702,137
Leesville	McGuire Creek	48	17,900	19,600	7.0	594,237
Totals		5,692	1,326,400	212,800		$22,252,596

outlet structure is located in the west abutment of the main embankment and is separated from the embankment by a retaining wall. The structure consists of an overflow gravity section with outlets and slide gates.

The dam and outlet works of the Mohicanville structure are identical with those of the Charles Mill structure except that they are of the opposite hand.

The Piedmont Dam is of the rolled-fill type, consisting of an impervious section reinforced with heavy rock fills. Because of foundation conditions, the side slopes are very flat. A saddle spillway with a concrete-lined control section is located west of the north abutment. The outlet works consist of an intake with gates, a concrete-lined horseshoe-shaped tunnel, and a stilling basin.

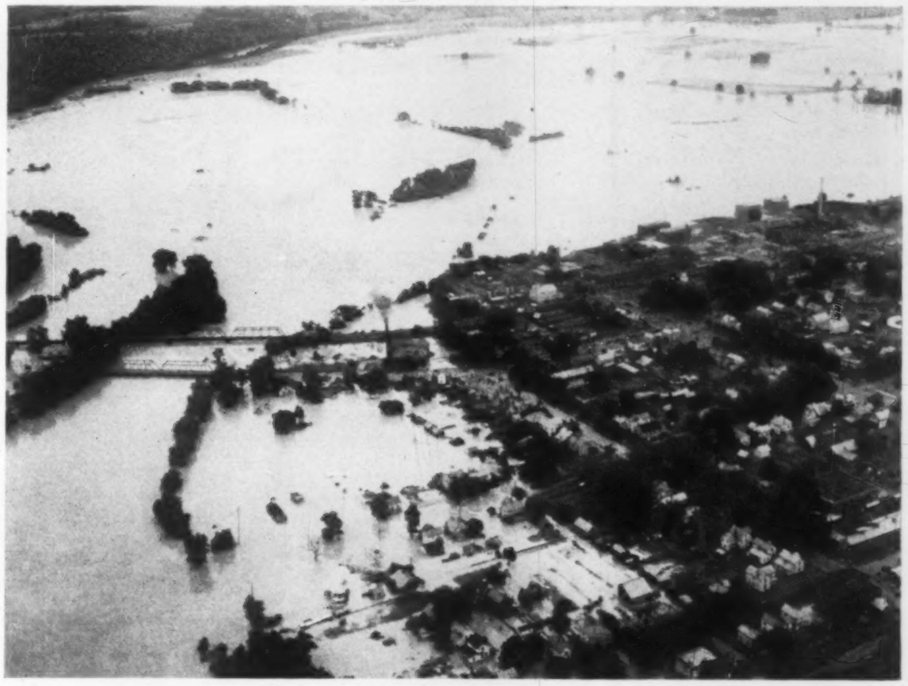
The Clendening Dam is of the rolled-fill type with an impervious core and a pervious shell, and is reinforced by rock-fill slopes. The spillway, located in the west abutment, is a deep rock cut with no concrete lining. The outlet works are made up of an intake with gates, a concrete-lined horseshoe tunnel, and a stilling basin.

The Tappan Dam is of the rolled-fill type with an impervious section reinforced with a heavy rock fill at the downstream toe. A saddle spillway is located in the south abutment. The outlet works consist of a concrete intake with gates, a concrete-lined tunnel, and a stilling basin.

The Beach City Dam is of the rolled-fill type with an impervious core and pervious shells. A concrete-lined saddle spillway is located in a natural saddle in the south abutment. The outlet works consist of an intake, two cut-and-cover conduits, and a stilling basin. This dam is an interesting example of an embankment on a pervious foundation.

The Dover Dam is a concrete gravity type with an overflow spillway in the central part. Flood waters will be controlled by 18 slide gates located within the dam. The construction of the dam itself is a minor part of the total construction program in this area, the major part being relocation of several railroads and public utilities.

The Bolivar Dam is of the rolled-fill type and consists of an impervious core with pervious outer shells. The dam is the longest under construction, being some 6,500 ft in length. A concrete-lined saddle spillway is located in the west abutment in a natural saddle. The outlet works consist of an intake, twin concrete-lined tunnels, and a stilling basin.



View of Coshocton, Ohio, on August 8, 1935

This Photograph, Taken with the Flood 3 Ft Below the Crest, Speaks for Itself in Illustrating the Need for Flood Control Works in the Muskingum Basin. Coshocton Is at the Junction of the Walhonding and Tuscarawas Rivers

The Atwood Dam is of the rolled-fill type with an impervious core and a pervious shell. A concrete-lined side-channel spillway is located in the north abutment. The outlet structure lies in the creek bed and consists of an intake tower, three cut-and-cover conduits, and a stilling basin. A trunk gas line consisting of an 18-in. and a 20-in. pipe has been relocated near this dam.

The Leesville Dam consists of a rolled impervious core with pervious shells. A concrete-lined saddle spillway is located in the south abutment. The outlet works consist of an intake, a concrete-lined tunnel, and a stilling basin. The tunnel is being driven in sandstone without the use of liner plates.

History of the Muskingum Project

By C. C. Chambers

Member American Society of Civil Engineers

Chief Engineer, Muskingum Watershed Conservancy District, New Philadelphia, Ohio

SINCE the beginning of history man on one hand has been seeking continually for a better and more abundant supply of water, and on the other for protection from uncontrolled water. Water is our most valuable natural resource. Its uses are legion and are continually increasing, but reports of flood disasters are still too frequent.

That the trend of civilization in a new country normally follows the sources of greater water supply, is witnessed by the geographic distribution of the centers of population in this country. In the main, our larger communities are located on bodies of water, and the early trend in the Muskingum area was no exception. At the point where the Muskingum River empties into the Ohio River, General Putnam and a group of men who landed there in April 1788 founded the first permanent settlement in Ohio. Farther upstream on the Muskingum River is Zanesville, settled eight years later than Marietta, at the crossing of the old Zane Trace. Coshocton was founded where the Tuscarawas River and the Walhonding River join to form the Muskingum. Pushing up the Tuscarawas River we find Newcomerstown, and still farther on the historic spots of Gnadenhutten, the site of early Indian missions, and Zoar, the communist settlement. Along this river also were established the cities of New Philadelphia, Dover, and Massillon; and, finally, near the headwaters of the Tuscarawas, we find an exception in Akron, which is perched on the divide between the Tuscarawas and the Cuyahoga drainage systems. Communities were established first on the main streams because of water transportation, but later pioneers in the Muskingum drainage area settled on some of the smaller tributary streams.

AUGUST FLOOD FAILS TO SUBMERGE SENECAVILLE DAM
When This Photograph Was Taken the North Embankment Was Approaching Completion. The South Embankment Had Not Yet Been Started

REGULATION REQUIRED FOR BEST USE OF WATER

Again, these communities in the Muskingum area were not an exception to the rule when they found that some regulation was required before they could enjoy the best use of, and protection from, the waters of the streams. The eagerness to settle along streams created large centers of population and investments in the valleys, that grew rapidly before it was fully realized that they were in danger from the very thing they sought. Due to the comparatively rugged topography of some parts of the district, many of the most important arteries of transportation and communication were constructed in the stream valleys. As most of the streams lack channels large enough to carry the water of great storms, these cities and towns are in exposed positions and have been left unprotected or so poorly protected as to be subject to great financial damage and loss of life from floods. It follows naturally that these communities have long records of flood experiences, but the memory of one great flood gradually fades before the next occurs. Development has been rapid in the interims, and there are improvements, the very existence of which creates new and augmented flood hazards.

There are physical evidences and historical records of the efforts made to cope with this problem, though in most cases these efforts have been unable to keep pace with the need. This work was somewhat piecemeal and showed a lack of realization of the extent of the problem until after the flood of 1913, when various communities in the Muskingum area made a more thorough investigation to determine what could be done to protect against a repetition of such destruction. Many solutions were proposed. Some thought the only solution could be found in deepening, widening, and straightening the stream channels; others advocated reforestation and construction of a multitude of check dams and ponds on the headwater streams; and still others favored large flood-control reservoirs.

Various cities in the area engaged engineers to make studies and recommend plans for the solution of their particular problems. In some cases it was found that complete protection by local improvements was almost physically impossible, while in others the cost of any plan for adequate local protection was greater than the individual communities could bear. In some cases plans were suggested that could be carried out at a moderate cost but would afford only partial protection. These were urgently advocated in some instances, but it is fortunate that the cities did not yield to that temptation, as partial protection may be worse than none. Any city of considerable size that aspires to be a permanent factor in the industrial and business life of our country by the utilization of flood areas for industrial business and residential expansion, should have protection against any flood that is likely to occur.

A COMPREHENSIVE PROGRAM VERSUS INDIVIDUAL ACTOIN

Some engineering studies made subsequent to 1913 suggested that the only rational solution might be a comprehensive plan for the entire drainage area and that the matter of flood control might well be linked with some of the other water problems of this region. The expense of the investigations necessary to determine the possibilities of such a comprehensive program was beyond the ability of any single community. Through the untiring efforts of the early pioneers for this project, there was a general awakening throughout the district to a realization of a community interest in the water problems of the Muskingum drainage area, which was crystallized in the organization of the Muskingum-Tuscarawas Improvement Association. Some sponsors were interested primarily in navigation, some in water power, reforestation, headwater control, and other aspects, but the interest in flood control was general.

Through the efforts of this organization a preliminary water survey was made for the entire drainage area, which disclosed that the development of water power was not economically feasible and that the improvement of the main streams for navigation seemed unwarranted. Although the towns and cities felt that their water supplies were fairly adequate and satisfactory, some were nearer an acute water problem than they realized and future expansion would be hampered unless water was conserved. The survey also showed that it would be feasible to plan and execute a comprehensive flood-control and water-conservation program for the entire drainage area, but that it might cost over $50,000,000, an expense more than the District and state could bear. It was found, however, that the control of the Muskingum flood waters would have a measurable effect in reducing flood crests on the Ohio River and would benefit navigation, for which benefits there was a community interest in other states and in the federal government.

The Muskingum River drains 23 per cent of the Ohio River watershed at Marietta and over 10 per cent at Cincinnati. In nearly all cases the flood crests in the Muskingum River reach Marietta a short time before, or synchronize with, the flood crests from the upper Ohio River, so that flood waters from the Muskingum materially increase flood heights at and below Marietta, and add to those on the lower Ohio and Mississippi rivers. The lowering of the Muskingum flood crests by reservoir control therefore will cause a measurable reduction of flood heights along these parent streams, and will provide computable economic benefits, which will be of continuing and increasing value in case reservoir control is added on other large tributaries of these main streams.

A View of Clendening Dam in the August Flood

Note Spillway Excavation in Left Center, and Flooded Portal Excavation Just to the Right of the Spillway

CONSERVANCY DISTRICT IS ORGANIZED AND BEGINS WORK

On June 3, 1933, the Muskingum Watershed Conservancy District was organized and created under the Conservancy Act of Ohio, with a territory covering most of the drainage area of the Muskingum River—an area about one-fifth that of the State of Ohio. The District so created provided the legal machinery necessary to prepare plans, execute, and operate a comprehensive flood-control and water-conservation project. It provided the means to secure the necessary financial cooperation between the individual property owners and the communities of the District in proportion to their benefits, and also gave a body with authority to enter into contracts with the federal government and the State of Ohio.

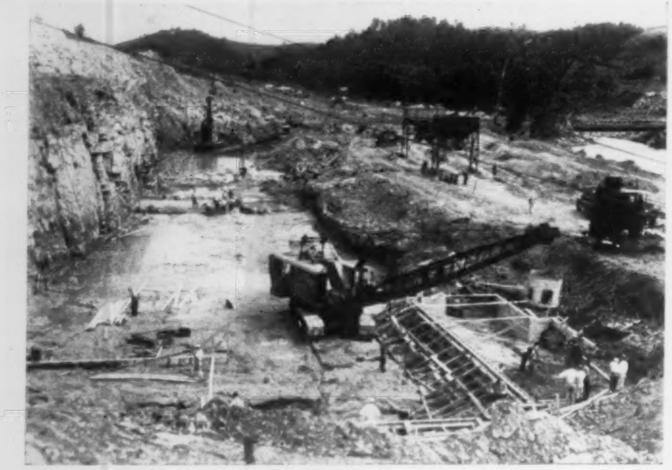
A comprehensive general plan was prepared which provided for a system of main flood-control and water-conservation reservoirs supplemented by channel improvement and local protection works at cities and other critical points. In addition, a number of small reservoirs were planned for some of the tributary streams, to provide for water conservation and local flood control. This plan recognized that the work would not be completed until it was pushed back to the very headwaters of the streams and to the hillside slopes. It included reforestation work on the steeper slopes and soil erosion control in cultivated fields, not only to preserve the forests and soil but also to retard runoff, conserve water, and prevent the filling of the reservoirs with silt.

In August 1933, the District made application to the Federal Emergency Administration of Public Works for aid in constructing and financing this project. In December 1933, an allocation of $22,090,000 was made by PWA to the U. S. Corps of Engineers for the construction of the 14 main flood-control and water-conservation reservoirs. The amount was determined by adding to the ordinary PWA grant of 30 per cent of the construction cost, the estimated benefits from the reduction of flood crests on the Ohio River and improvements to navigation.

The work on these reservoirs is being carried forward under an agreement, dated March 29, 1934, between the District and the U. S. Government, through PWA. This agreement provides that the allocation be made available to the Corps of Engineers of the War Department for the preparation of plans and all construction work except highway relocations; and that the Conservancy District assume the responsibility for the cost of all lands and rights of way and the expense of relocating all highways. These items together were estimated to cost more than $12,000,000.

Subsequent to the signing of this agreement, the District entered into a contract with the director of highways of the state, which provides that the highway department will make all necessary relocations of roads, highways, and streets, in consideration of the benefits to be derived by the state from the project, particularly in the reduction of flood damage to highways within the District and along the Ohio River.

In further consideration of the benefits to the state, an appropriation of $2,000,000 was made to the District to aid in the acquisition of rights of way. The remaining $6,000,000 or more will be raised by a levy on the appraised flood-control benefits to property within the District, in accordance with the Conservancy Act.



WILLS CREEK DAM OUTLET WORKS

A PLAN IS FORMULATED

Federal and District funds were not available until May 1934 for actively carrying forward an intensive attack on the problem. Due to the emergency requirement of getting work started quickly in order to relieve unemployment, things had to be done in a few months that ordinarily would have required years. The U. S. Corps of Engineers responded courageously to this challenge and worked diligently to organize and prosecute the engineering work required in the preparation of plans for the reservoirs.

The tentative location of reservoirs was prepared as part of a general plan, with an attempt at an economic balance of reservoir control with supplemental local improvement work. The limitation of the federal allocation to reservoir construction gave a slightly different approach to the problem of reservoir design, in order to determine the best system, balance of size, number, and location of reservoirs that could be built with the available funds.

It was recognized that detailed investigations would probably dictate some changes in the tentative plan, which was completed early in August 1934. This plan was in sufficient detail to fix the size, number, and location of reservoirs and the general design of the structures. The detailed estimates which followed showed that some of the reservoirs could be changed to more expensive locations on larger streams, providing more effective control of flood waters without increasing the preliminary estimate of cost. The expense to the local interests for the purchase of rights of way was increased somewhat, but the benefits to the District were greater.

Since the legal and financial standing of the plan was founded in the District, it was necessary for the District to cooperate in the preparation of the plan and to make it official in conformity with the requirements of the Conservancy Act. Hearings were held on the proposed plan before the board of directors after the prescribed notices by publication. At the completion of these hearings, the board adopted an official plan. Objections to this were heard by the conservancy court, composed of one common pleas judge from each of the 16 counties within or partially within the District, 30 days after the official plan was adopted by the board. The official plan was approved by the conservancy court on November 19, 1934. In the meantime, detailed designs and contract drawings were completed, so that the U. S. Engineers' office was ready to award contracts and to start actual construction work before the end of the year. Subsequent to the presentation of the plan of the reservoirs for approval, it was determined that a shift in the location of one reservoir would be advantageous to all interested parties. This was accomplished by an amendment to the official plan, as provided for in the Conservancy Act.

Although the work being carried forward under the original contract between PWA and the District covers in the main only the construction of the principal reservoirs, the District is arranging, as opportunities are offered, to complete the other parts of the original comprehensive plan.

SOIL EROSION STUDIED

In response to requests of the District, PWA has allocated about $500,000 to the Soil Erosion Service to conduct a soil erosion project on the 90,000-acre Salt Creek drainage area within the District. This work has been carried forward with satisfactory results. The work has demonstrated that farmers will cooperate with governmental agencies in this type of work, that the processes of erosion can be checked, and that the methods used do check erosion and conserve soil.

Due to a local interest in the prevention of soil erosion and in reforestation, a soil erosion demonstration station was established near Zanesville in 1932 by the Department of Agriculture. The results obtained at this station have been invaluable for the more extensive work done by the Soil Erosion Service. In addition, the Soil Erosion Service has made an erosion survey of the entire Muskingum drainage area, and the state has conducted a soil classification survey of this area. These data are now available for the planning and execution of a program for soil-erosion control and reforestation, and for farm use. During the past two years there have been several CCC camps at work in the District on reforestation and the checking of erosion, which has advanced to the stage where gullies are being washed out.

The Department of Agriculture, in cooperation with the District, is planning to set up on a drainage area of several thousand acres an experimental laboratory in which to observe over a long period of years the actual effects on rainfall runoff, soil losses, silting, and groundwater percolation resulting from different methods of land use. It is believed that the results from these observations will be valuable not only to the District but to the engineering profession at large.

PROJECT WILL HAVE FAR-REACHING EFFECTS

The advantages of the physical changes that are now in progress of construction will not be permanent without a plan to adapt society to these changes. Over 32,000 parcels of real property will be affected by the construction of the project. The District is putting forth every effort that is economically justified and legally permissible to help direct the readjustments that are bound to follow these changed conditions. Any successful efforts in assisting families and businesses to a satisfactory relocation will react favorably to the District in lower costs for the required rights of way. A better use of the advantages to benefited property due to the relief from flood hazards and the beneficial uses of water conservation will increase the financial security of the District.

The success of the project up to the present time is due largely to the spirit of cooperation shown from its very inception, and maintained through the entire period of development. This was first shown by the pooling of individual interests in a common effort; then by enlisting the support of nearly every community in the District, looking toward the accomplishment of an enterprise for the common good; and finally by individuals and local, state, and federal governments cooperating, each contributing to the work in proportion to its respective benefits and responsibilities.

General Design of the Muskingum Project

By T. T. Knappen

Associate Member American Society of Civil Engineers

Senior Engineer and Chief of the Engineering Division, U. S. Engineer Office, Zanesville, Ohio

The problem involved in the Muskingum project is to provide an adequate flood control system for the Muskingum basin, and at the same time to provide as much water conservation as practicable within the limits of available funds. The general plan was worked up in close cooperation with the engineers for the Muskingum Watershed Conservancy District, represented by C. C. Chambers, chief engineer of the Conservancy Board.

Referring to Fig. 1 of Mr. Winslow's article, a map showing the official plan of reservoirs, it will be seen that the first main tributary of the Muskingum is the Licking, coming in at Zanesville. As flood-control studies have shown that the main crest comes out of the Licking River too early to interfere seriously with the crest from the main Muskingum, no work on the Licking is included in the project. The drainage area above the mouth of the Licking at Zanesville is slightly over 6,000 sq miles. The next main tributary is Wills Creek, having a drainage area of 853 sq miles. The collection characteristics of Wills Creek are such that it is apt to contribute its peak close to the peak of the main flood in the Muskingum River.

The main stem of the Muskingum is formed by the junction, at Coshocton, of the Walhonding River, with a drainage area of 2,252 sq miles, and the Tuscarawas River, with a drainage area of 2,590 sq miles. The main tributaries of the Walhonding are Killbuck Creek, the Mohican River, and the Kokosing River. The main tributaries of the Tuscarawas are Stillwater Creek, with a drainage area of 485 sq miles; Sugar Creek, 356 sq miles; Conotton Creek, 286 sq miles; and Sandy Creek, 503 sq miles. Above the junction of Sandy Creek, the total drainage area is 588 sq miles.

Stillwater Creek, the lowest tributary of the Tuscarawas, has a very slow collection rate, and discharges its peak at about the same time as, or a little later than, the peak from the upper river. The runoff from the rest of the tributaries of the Tuscarawas is rather rapid, except for the 400 sq miles above Massillon. The tributaries of the Walhonding River have a rapid rate of discharge and produce a crest at Coshocton 24 to 36 hr in advance of the peak from the Tuscarawas River.

RAINFALL RECORDS GO BACK A HUNDRED YEARS

Until 1935, one hundred years of record in the Muskingum valley showed that practically all of the greater floods occurred the latter part of March and early in April. At this time the ground is generally either frozen or saturated, and heavy storm movements from the Gulf, passing up through the Ohio River basin, frequently result in heavy precipitation on the Muskingum drainage area. Generally, summer floods have been small, and although great intensity of rainfall has occurred over small areas, the distribution has not been such as to seriously affect the main river.

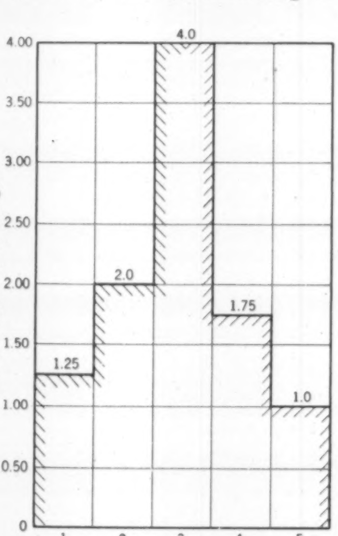
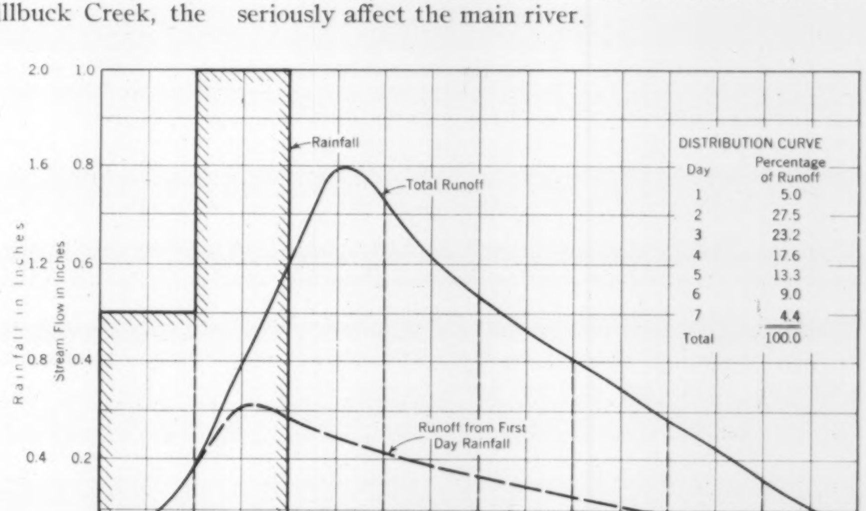


Fig. 1. Official Plan Storm
Total Rainfall Volume 10 In.

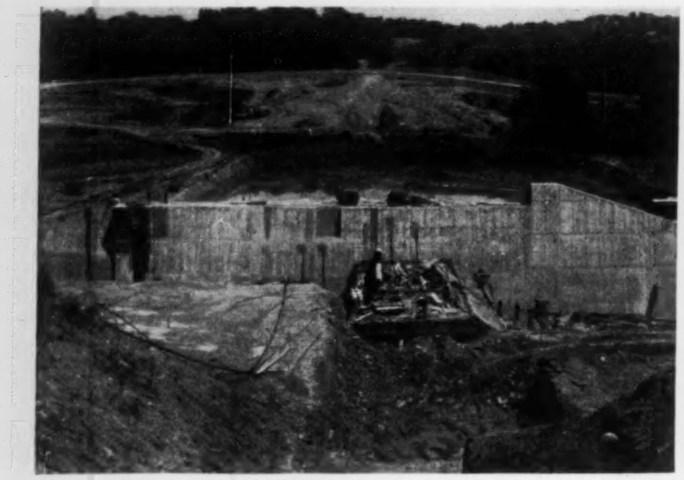


DISTRIBUTION CURVE

Day	Percentage of Runoff
1	5.0
2	27.5
3	23.2
4	17.6
5	13.3
6	9.0
7	4.4
Total	100.0

Fig. 2. Typical Runoff Distribution Curves for Muskingum River Basin
Such Curves Give Satisfactory Results for Small Areas

In March 1913 a 5-day storm occurred in the Muskingum basin which produced the greatest flood of record, almost twice as great as that of any before or since. At that time there was an average rainfall over the whole basin of 7.33 in., varying from 9.16 in. on the Walhonding, to 6.55 in. on the Tuscarawas watershed. The condition of the soil was such that approximately 85 per cent of the rainfall went into runoff.



WEST ABUTMENT OF CHARLES MILL DAM
Photograph Taken Along Center Line of Dam Site

OUTLET WORKS, CHARLES MILL DAM
Here the Outlet Works and Spillways Will Be Combined

In August 1935, the greatest discharge since March 1913 occurred at Zanesville. This represents what was probably the fifth greatest flood of record, approaching the magnitude of all other floods except that of March 1913. The average rainfall over the watershed was 3.82 in., the maximum intensity 12 in., and the duration approximately 14 hr. Two days preceding, there had been a general rain of 2 in. over the watershed, and the combined runoff from storms was approximately 50 per cent of the rainfall. While agricultural losses were widespread, no serious urban loss resulted.

STORM CHARACTERISTICS USED FOR DESIGN

A study of storm distribution in the past indicated that no particular distribution of rainfall could be expected in a great future flood. According as it was necessary to assume certain maximum probable conditions, a 10-in. uniform distribution of rainfall was assumed. This distribution was assumed to take place over five days, as shown in Fig. 1, and as follows: 1.25 in. the first day, 2 in. the second day, 4 in. the third day, 1.75 in. the fourth day, and 1 in. the fifth day. While this is the approximate distribution of the March 1913 storm, the average rainfall is 35 per cent greater. In view of the runoff relation in 1913, it was further decided that 90 per cent runoff would be assumed, that is to say, a runoff of 9 in.

In order to check the reservoir capacities and to route the floods, it was necessary to develop hydrographs for the 1913 storm and for the official plan storm at various points in the basin, particularly at the dam sites proposed, at junctions of tributaries, and at the main towns along the rivers. No uniform hydrographs could be adopted because the different streams in the basin have widely varying runoff characteristics. In only a very few cases were reliable records available as a guide in preparing the hydrographs for the 1913 storm. It was necessary, therefore, to adopt some method of reconstructing these hydrographs.

The unit graph method was selected as the one most likely to provide the required information. Essentially, this method sets up a hydrograph at a given point for the runoff from 1 in. of rain in a given period selected, over the drainage area above the point. It is possible to develop such hydrographs for typical storms of small magnitude from existing records. Once a typical hydrograph is developed, it can then be used for greater or less rainfall by multiplying by the ratio of actual rainfall to 1 in., and can be corrected for the percentage of runoff by the same method.

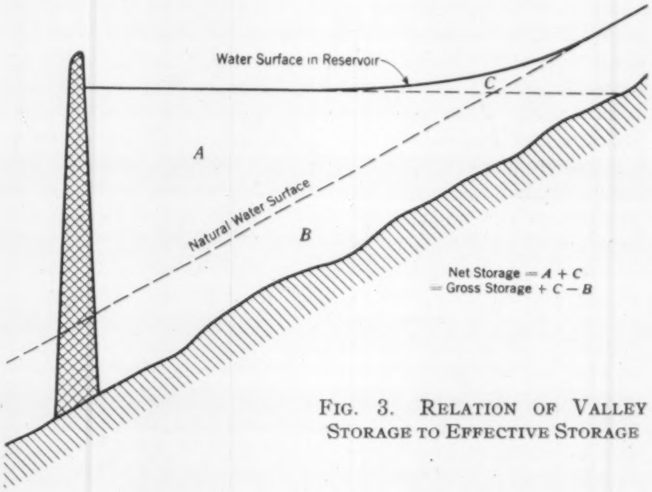


FIG. 3. RELATION OF VALLEY STORAGE TO EFFECTIVE STORAGE

Where rains occur on several successive days, the runoff ordinates for the various days of rainfall for each of the days of the runoff period may be added together to produce a distribution graph for any particular storm. In the lower curve of Fig. 2 is shown the unit graph for the first day's rain corrected for volume, and in the upper curve the distribution curve for the two days' rainfall. This method works fairly well on small areas. For large areas it is difficult to work out, as it rarely happens that storm distribution is uniform. However, by developing these hydrographs for small areas and combining the various distribution curves by flood routing methods, hydrographs for large areas can be developed. The results of such combinations may be checked with known points, a few of which were available in 1913. By this method, the 1913 flood was reconstructed for the Muskingum basin, and hydrographs for the official plan flood were prepared.

DETERMINING BEST DISTRIBUTION FOR RESERVOIRS

Having developed the hydrology of the watershed, the next step was planning the reservoir system, which should be one of wide distribution. Approximately two thirds of the area must be under control, and the reservoirs must be well distributed over the whole area; otherwise, a storm of great intensity over a small area may occur in such a way as to produce a great flood without developing much of the reservoir storage. The storm of August 7–8, 1935, was an illustration of such a storm.

Reservoirs located on comparatively small drainage areas, for example, 200 sq miles or less near the headwaters of the drainage area, are valuable units in the system because they generally have a low cost per acre for the storage, while the resulting benefits extend from the headwaters down. But such reservoirs cannot control a large enough area to do the whole job, and in the Muskingum basin a system made up of reservoirs of this type alone, costing the same as those on the official plan, was found to be only half as effective. Consequently, only the best reservoirs of this type were used.

It is necessary, therefore, to plan on large reservoirs located at key points on the main tributaries where large drainage areas may be controlled. While the location of such reservoirs lower down on the stream restricts their benefits to smaller areas, they present the advantage that smaller storage capacity in inches of runoff can be utilized more often to benefit the areas below, as they control larger drainage areas. Further, this type of reservoir is essential to get the required area under control.

DETERMINING SIZE OF RESERVOIRS TO PROVIDE CONTROL OF FLOODS

The size of the flood control reservoirs was based on the size of the official plan flood, that is, the largest flood that was expected. In determining the maximum size, the runoff from the drainage area was assumed to be 9 in. Obviously, the reservoir should not have a greater flood control capacity than this. However, the probability of getting 9 in. of runoff from any particular area is so extremely remote that the full capacity of such a reservoir would almost never be developed. Further, as wide a distribution of storage as possible is desirable, and it is always possible to release some flow from the reservoirs if there is likelihood that the capacity of any particular reservoir will be exceeded. Our studies indicated that flood control storage in excess of 7 in. of runoff from the drainage area was not justified. In general, the 7-in. size was used for the reservoirs of about 200 sq miles of drainage area or less. For reservoirs having larger tributary drainage areas, the probability of 7 in. of storage is even more remote. In addition, the channel capacities are such that permissible releases do not generally require this size.

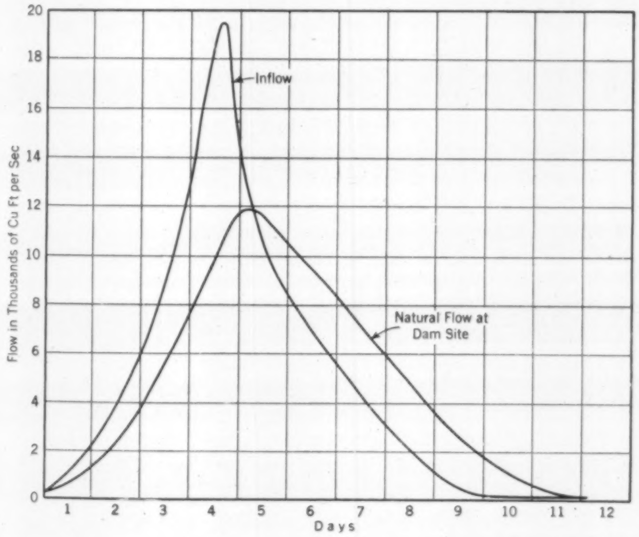


FIG. 4. OFFICIAL-PLAN FLOOD HYDROGRAPHS, CHARLES MILL RESERVOIR

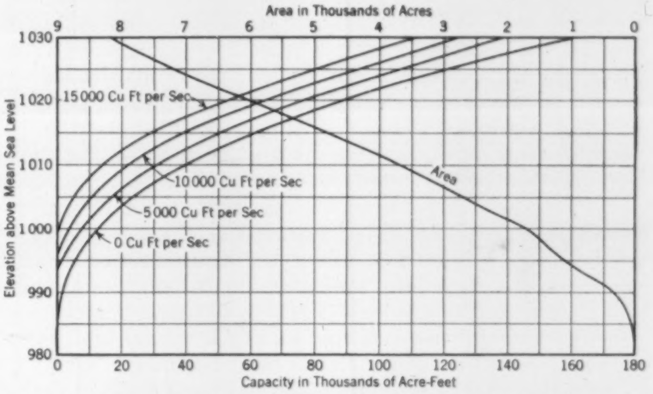


FIG. 5. AREA AND CAPACITY CURVES, CHARLES MILL RESERVOIR

Capacity Curve for Zero Discharge Is Final; Other Capacity Curves Are Subject to Revision. The Drainage Area Is 216 Sq Miles

The determination of minimum size for reservoirs involves other considerations. In passing through a reservoir basin prior to the construction of the dam, a large flood would occupy a considerable amount of valley storage. The net effective storage would be reduced accordingly, as illustrated in Fig. 3. In some cases this may amount to as much as 2 in. of runoff from the drainage area. Obviously, a reservoir having 3 in. of storage in this case would have only 1 in. of net storage, giving 33 per cent efficiency. Final studies indicate that, when valley storage is taken into consideration, the minimum storage ordinarily should be not less than 5 in., although in one case we went to as low as $4^1/_2$ in.

CONSIDERATIONS OF STORAGE FOR WATER CONSERVATION

Part of the project required the development of water conservation to replenish the low-water flow in dry seasons; to increase the ground-water flow; and to provide recreational facilities, local water supply, and water supply for industrial purposes.

Nowhere in the watershed has it been practicable to combine the same storage space for both flood-control and water-conservation purposes, as the probable time of occurrence of a flood and the latest date for starting water-conservation storage are too uncertain. However, at many locations the cost per acre-foot of a combined flood-control and water-conservation reservoir is less than the cost per acre-foot of a simple flood-control, or a simple water-conservation reservoir. Economy may be obtained in such cases by developing both flood-control and water-conservation storage in one reservoir.

Generally speaking, economical water-conservation storage can be obtained in the headwater reservoirs. Wherever practicable, therefore, water-conservation storage equivalent to 7 in. or less of runoff from the tributary drainage area was provided in the headwater reservoirs. On some of the larger flood-control reservoirs, small permanent lakes are provided, largely for recreational purposes.

MAKING PRELIMINARY RESERVOIR LOCATION STUDIES

Based on the U. S. Geological Survey maps and field reconnaissance, all possible reservoir locations in the Muskingum Conservancy District, 151 in number, were studied. These preliminary investigations consisted in preparing area-capacity curves and studying the topography to determine whether reservoirs were feasible at these various locations. Those which showed some promise from the map studies and field reconnaissance were further investigated.

Preliminary designs and dam cost estimates were based on a careful field reconnaissance of each dam site, with a cross section run along the approximate axis of the proposed structure, and a geological report on each site. Among the additional costs considered were that for relocation of railroads, public utilities, and highways, and that for flowage in each reservoir basin.

Based on these preliminary data, a capacity-cost curve was prepared for each reservoir, and several possible systems of reservoirs were set up, within fund limitations. Hydraulic characteristics of the various systems were checked roughly, and the most likely system selected. This system had several possible alternatives where comparative cost studies made it difficult to choose between reservoirs in various localities. Eighteen reservoirs forming the basic system and alternates were thus adopted for further study.

RESERVOIR MAPPING AND FINAL LOCATION STUDIES

Studies had been based on U. S. Geological Survey maps, on a scale of 1 in. to the mile and a contour interval of 20 ft. It was realized that, since many of the reservoirs had only 25 to 35 ft of flood control storage at the dam, the capacities planimetered from the Survey sheets might be considerably in error. It was felt, therefore, that final reservoir designs could not be carried forward until complete surveys, on a scale of 1:10,000 (roughly 800 ft to the inch), with a 5-ft contour interval, were available. Surveys were started on each reservoir as soon as preliminary studies indicated that it had a good chance of being included in the plan, and ultimately reservoir surveys were made for 18 reservoirs Photographic methods were used in making surveys. Horizontal and vertical control was provided by level and transit lines between existing bench marks. Photographs were taken to an approximate scale of 1:10,000, and scales were checked and rephotographed to an exact scale of 1:5,000. Topography was taken in the field on the 1:5,000 photographs by plane-table methods. The final maps were prepared by pantographing the field data and the photographic data onto the base sheets. As fast as the sheets were completed, property lines were added and the sheets planimetered to determine curves of reservoir capacity.

As a basis for the preliminary design of the various dams and for cost estimates, contour maps of each dam site (at a scale of 100 ft to the inch and a contour interval of 1 ft) were prepared by plane-table methods. In some cases, these surveys were made in connection with the preliminary studies; in other cases, the surveys were not made until this stage of the field investigations.

For the dam sites which seemed likely to be included in the plan, detailed preliminary investigations of the subsurface conditions were made. These investigations consisted of from 5 to 20 dry sample and core borings to develop the geological characteristics of the site, and sufficient auger borings and test pits to develop possible borrow pits and to determine the suitability of excavation materials for embankment use. After a site was definitely selected, more extensive investigations were made.

As soon as a site was tentatively selected for inclusion in the plan, preliminary railroad reconnaissance surveys were immediately undertaken for any railroads involved. Based on these surveys and map studies, and on geological investigations of the materials to be excavated, preliminary estimates of railroad relocation costs were prepared.

Public utility surveys consisted, to a very large extent, in determining the extent and physical characteristics of the public utilities in the proposed reservoir basins. Generally, a plan could be developed for the relocation and a close estimate made without a detailed survey, prior to final inclusion of the reservoir in the plan. However, a large amount of work was necessary to inventory the public utility facilities. Based on these surveys and reconnaissance, detailed estimates of the cost of these relocations were determined. In the case of railroads and public utilities, numerous conferences were held with the officials of the corporations involved prior to preparation of the estimates.

Representatives of the U. S. District Engineer Office, in cooperation with officials of the Muskingum Conservancy District, made reconnaissance surveys, based on the reservoir maps where possible, to determine what the cost of flowage would be. At the same time, the State Highway Department was making preliminary and reconnaissance surveys to estimate the cost of highway relocation work in connection with the project.

DETAILED STUDIES MADE FOR FINAL HYDRAULIC DESIGN

As a basis for the hydraulic design of the system, a general operating plan for the reservoirs had to be adopted. The basic principle of this plan is that no water will be released during a flood from any reservoir that will cause the channel capacities below to be exceeded. In order to meet this requirement at points well downstream, it may be necessary, at some reservoirs, to discharge a considerably smaller amount than the channel capacity immediately below can handle.

In determining the effectiveness of the reservoir system, it is necessary to know the rate of inflow to each reservoir. As previously stated, we were generally able to reconstruct, or to construct, hydrographs at the dam sites for the 1913 storm and for the official plan storm. However, the hydrograph of inflow into a reservoir is quite different from the hydrograph at the dam site. In some cases, the rate of inflow into the reservoir may be twice the maximum discharge at the dam site (Fig. 4). In order to arrive at the hydrograph of inflow to the reservoir, it was necessary to determine the valley storage in the reservoir basin for various discharges at the dam site. This was done by plotting the water surface in the basin, assuming no dam to exist, and determining, by planimetering, the storage in the reservoir basin. Figure 5 is a capacity curve corrected for valley storage for various flows at the dam site. From this curve the net available storage for any flow at the dam site may be determined. The required outlet discharge may then be worked out for any known flood hydrograph. Starting with the outlet hydrographs at each dam site, and adding to them the inflow hydrographs for the tributary areas below the dam site and correcting for valley storage, floods could be routed down through the stream channels below to determine a modified hydrograph at any desired point.

The size of outlets was primarily determined by the maximum discharge that would be required from the reservoir as a result of the reservoir operation studies previously described. Generally speaking, each outlet is controlled by several gates, and one excess gate is provided to insure that the desired discharge can be obtained even though one gate is out of operation and closed. The different reservoirs provided many different problems in selection of outlets and gate-control structures.

Two general criteria were used in the design of the spillways. The first criterion was a runoff from the drainage area of from 14 to 17 in., depending on its size, occurring in a 3-day period and conforming in the shape of the hydrograph to a normal hydrograph for the basin. It is assumed that at the beginning of the flood the reservoir is at conservation level and that all gates are closed, and that the gates remain closed during the entire flood. Under this criterion sufficient spillway capacity is provided to maintain a freeboard of 5 ft on the dam. The second criterion is that, to provide against the extremely remote possibility that a great storm will occur when the water in the reservoir is at spillway crest, the spillway capacity is required to be sufficient to take care of a runoff volume varying from 10 to 17 in., depending on the size of the reservoir, starting with the reservoir at spillway level, and maintaining a freeboard of 2 ft below the top of the dam.

As this was a PWA project requiring that all work be under way by the summer of 1935, it was necessary to have the plans for most of the work completed by April 1935. The plan had not been officially approved until the middle of November 1934. This placed a heavy load on the design sections and required a maximum personnel of close to 400 engineers and assistants.

DESIGN AND CONSTRUCTION ORGANIZATIONS

The responsibility for the design work was divided among three sections, known as the dam design, railroad design, and public utility design sections. These sections were supplemented by a hydraulic design section, a geological section, a soils laboratory, a concrete laboratory, and a specifications and cost estimate section.

All the work in the Zanesville District is under the direct supervision of Maj. J. D. Arthur, Jr., U. S. District Engineer. For purposes of construction, the District is divided into four areas, with headquarters at Dennison, Dover, Loudonville, and Zanesville, respectively. All construction work in each area is under the control of the area engineer. For each job or group of jobs, a resident engineer appointed, who has complete responsibility, under the area engineer, for carrying out the work under his supervision.

The District Office is organized into an administrative division and an engineering division. The administrative division carries out all necessary administrative work for the District and supervises the administrative work of the field organizations, while the engineering division includes all the design and laboratory sections and exercises supervision over all engineering features of the field work, as well as taking care of all design and inspection of special construction work.

Design of Dams for Muskingum Project

By A. L. ALIN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CHIEF, DAM AND RESERVOIR DESIGN SECTION, U. S. ENGINEER OFFICE, ZANESVILLE, OHIO

OF the 14 dams now under construction in the Muskingum watershed, 13 are of earth and one of concrete. The selection of the type of dam for each site was a difficult problem, calling for a study of topography, nature of foundations, available materials, and relative costs, in order to choose a design suitable for the conditions peculiar to that site. Only at Dover were conditions such that a concrete design could be used.

Geological conditions in the Muskingum basin are such that the greatest care must be exercised to secure structures that will function for many years without a decrease in efficiency or factor of safety. The rocks are of sedimentary origin, being composed of sandstone, shales, or indurated clay. Igneous or volcanic rocks are not found. At most of the sites rock appears only at the abutments and sometimes only at one abutment. The valley bottoms are filled with clay, silt, or sand and gravel, either in the form of alluvial deposits or as glacial tills. At some sites clay and silt of low bearing value must form the support for the embankments.

The earth dams are all being built as rolled-fill embankments. The hydraulic-fill method was considered for two sites, Pleasant Hill and Bolivar, since suitable materials were available. However, the location of borrow pits was such that pumping would have been required to place the materials, so the hydraulic-fill method was eliminated on the basis of cost.

FOUNDATIONS OF EARTH DAMS

Depending upon the character of the foundation, the design of the earth dams is somewhat different for unyielding pervious foundations consisting of sand and gravel to a great depth, than for foundations consisting of yielding materials such as clay, silt, or fine sand, to a depth varying from 8 or 10 ft to 50 or 60 ft. Three of the 13 earth dams—Mohawk, Beach City, and Bolivar—are founded on decidedly pervious strata. Sand and fine gravel are also found at the other sites, but underlying a thicker layer of impervious materials. The Mohawk Dam, with a maximum height of 115 ft, will be one of the highest ever built on a pervious foundation.

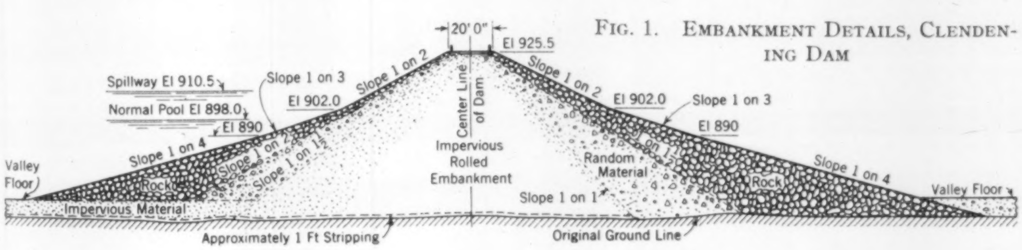
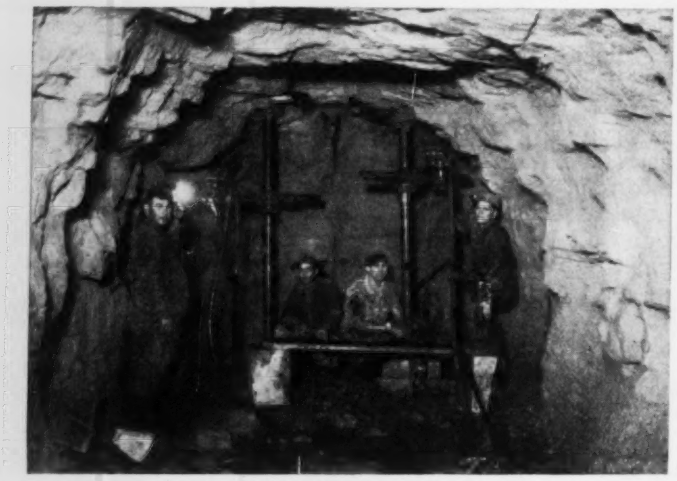


FIG. 1. EMBANKMENT DETAILS, CLENDENING DAM

Model experiments conducted by the soil laboratory, together with past experience, have demonstrated the necessity for providing a long path of percolation for water seeping through pervious foundations. This can be accomplished by horizontal extension of the impervious section of the embankment as a blanket, or by a vertical barrier in the form of a cut-off underneath the impervious part of the embankment. To prevent harmful seepage at the Muskingum dams, an upstream impervious blanket was used.



DRIFTER DRILLING OPERATIONS, TAPPAN DAM TUNNEL

Even in the most pervious foundations, it is found that a natural blanket of impervious materials exists. Full advantage should be taken of this in order to further lengthen the path of percolation beyond that provided by the artificial blanket. The natural blanket should be thoroughly investigated by means of auger borings to determine its efficiency, and wherever weakness is discovered, steps should be taken to patch with impervious materials.

At sites where the foundation materials are plastic, thorough investigations were made and stringent specifications written. Where the material was considered too plastic to support the superimposed load with safety, it was removed and wasted. At Charles Mill, material covering an area approximately 300 by 350 ft, and about 12 ft in thickness, was stripped to rock, in order to secure a firm support for the embankment. Where a slow rate of loading of plastic materials allowed sufficient consolidation to build up shearing resistance within a reasonable time, the rate of construction progress was specified. A close watch is being kept on any foundation movements. Settlement gages of a simple design are being installed in the base of some of the embankments to measure foundation consolidation.

Cut-off trenches along the axis of the dam were incorporated in the design of all embankments. Where foundation materials are pervious, a cut-off trench extending into the sand and gravel will break the continuity of the pervious formations or lenses. Where foundation material is of a less pervious nature and the natural impervious blanket is more pronounced, cut-off trenches seem hardly justified but should nevertheless be excavated and backfilled with selected impervious material, as they will insure against trouble from any seepage that may occur along the base of the dam due to imperfect stripping of the top soils.

A cut-off trench serves another important purpose for embankments on any foundation material except rock, as it explores the base of the dam for possible drainage systems. In the Muskingum watershed most of the dams are founded on farm land, or land that may once have been farmed, and tile drains and old pipes are often found from 1 to 4 ft below the surface of the ground. Exploration trenches were specified to be excavated to a depth of not less than 6 ft, in order to intercept such drains, and whenever encountered they are traced and removed throughout the full extent of the base of the embankment.

The incorporation of a rock toe trench in the design of any earth embankment is essential to secure a safe structure. It is located at the toe of the downstream slope to give an area of egress for water percolating through the embankment or foundation. Where a natural impervious blanket exists at the top of a sand and gravel formation, this toe trench should pierce the impervious layer and connect with the course materials below. The depth of these toe trenches varies from 6 to 15 ft, the 6-ft minimum being used in impervious ground. The bottom of all rock toe trenches is excavated on a slight grade, sloping toward the natural stream channel below the dam, to allow free drainage. Selected rock is used to fill the trench and is carried for some distance above the natural ground level. Reverse filters separate the rock fill from the impervious ground in order to prevent fine materials from being eroded and clogging the trench or causing settlement of the foundations.

The stripping of foundations serves a twofold purpose. The first is to remove all top soil in order to provide a satisfactory bond between the superstructure and the foundations. It is usually removed to a depth of 6 to 12 in. under impervious and random sections of the embankment. The second purpose is to establish free drainage under the pervious downstream sections of the embankment. Model experiments indicate a concentration of flow lines at the downstream rock toe trench, and, in order to increase the outlet area for water seeping through the pervious layer in the foundations, it is advisable to strip to those pervious layers. The depth of this stripping will vary from a few feet to 5 or 6 ft.

It is well known that, in the past, trouble with dams, particularly earth dams, has started at the abutments. Engineers have concerned themselves too much with the

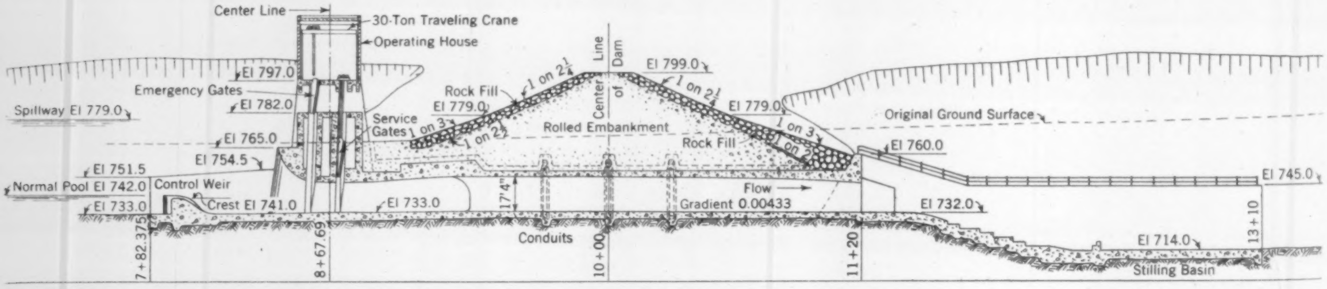


FIG. 2. CROSS-SECTIONAL ELEVATION, WILLS CREEK DAM
Showing Arrangement of Outlet Works

typical section of the dam and have paid too little attention to this vital point. Where the foundation is pervious and an upstream blanket is incorporated in the design of the typical section, this blanket must be carried up on the abutment slopes to such an extent that the length of the percolation path is maintained through any vertical section of the embankment, whether normal to the axis of the dam or at an angle with the axis. On abutment slopes where rock is found near the surface, the cut-off trench is carried up along the slope to the top of the dam. A concrete key wall, about 5 ft in height, is placed at the bottom of the trench and provision made for grouting the foundations. Where the abutment slopes are steep and the overlying talus is of too questionable a character to serve as a foundation for the dam, such materials are removed by stripping to rock.

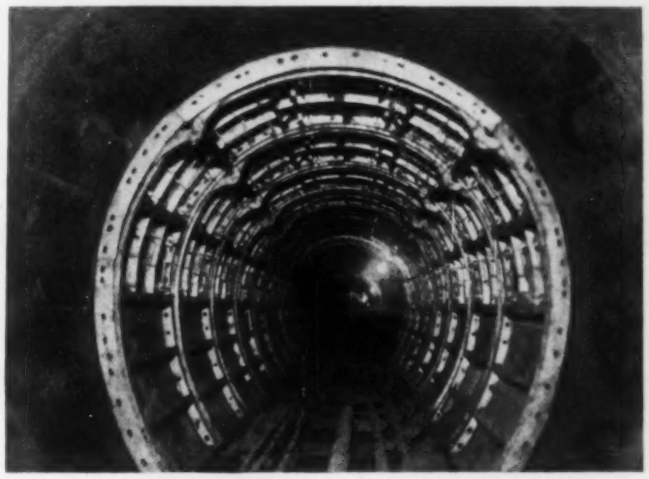
Wherever concrete structures are founded on rock, grouting of the underlying strata is being done along the center line of the dam. Two schemes for grouting operations are being used: One is to drill grout holes from the bottom of the rock trenches and to insert 1¹/₂-in. pipes, which are carried for a short distance through the structure. Grouting is done before the structure is carried any further. Another scheme is to carry 2¹/₂-in. pipes from the top of the rock to a given elevation in the overlying structure. Holes are then drilled through these pipes, and each hole is grouted before the adjoining hole is drilled and the operation repeated.

EMBANKMENT DESIGN

The design of a rolled-fill dam on an unstable foundation involves two important considerations: First, the economic section for the embankment, made up of available materials compacted to the desired degree; and second, the slopes required to prevent plastic flow of the foundation materials and subsequent failure by sliding. With pervious or stable foundations, the first of these criteria applies but the second may be disregarded.

In its place consideration must be given to the length of percolation path required to reduce the seepage to a safe value. However, the embankment section may be designed independent of seepage requirements and an impervious blanket extended upstream to lengthen the path of percolation.

The ideal embankment section is one with an impervious core, forming a water-tight barrier, and a pervious outer shell supporting the core and allowing free drainage upstream and downstream. The outer shell should be made up of materials graded from fine next to the core, to rock on the slopes. The drainage factor becomes important on the upstream slope when the pool is drawn down rapidly, and to prevent disturbance of the slope due to wave action. On the downstream slope the pervious section acts as a drain for any seepage through the core. The ideal embankment section will permit steeper slopes than would be allowed in embankments built up entirely of impervious materials. The minimum section for the impervious section of the embankments is first determined. At sites where large quantities of impervious material are available with economic hauling distance, the impervious section should be increased above these minimum requirements.



Tunnel Outlet, Clendening Dam

The final design of the embankments was governed by materials available from excavations for outlets and spillways and from borrow pits. Accessibility and cost of lands for borrow pits was given consideration. Advanced construction methods for building earth embankments and rigid field control now allow a wider range in choosing materials than has been possible in the past. Wherever possible, rehandling of materials from structure excavations is avoided by placing the material directly in the embankment. Thus it is seen that the construction schedule will affect the design of the embankment to some extent.

The Mohawk embankment is the nearest approach to the ideal section. A large supply of rock from outlet and spillway excavations is utilized for the outer shells. Pervious materials for an intermediate section are available from channel excavation and easily accessible borrow pits. Impervious material is also available from excavations for structures and from borrow pits. The balancing of the three materials has been computed on the basis of available quantities.

After the Mohawk Dam, the nearest approaches to the ideal section are in the Clendening and Wills Creek dams. Here the outer shells are made from an abundant supply of rock taken from excavations for spillway and outlets. As strictly pervious material is absent at these sites, the

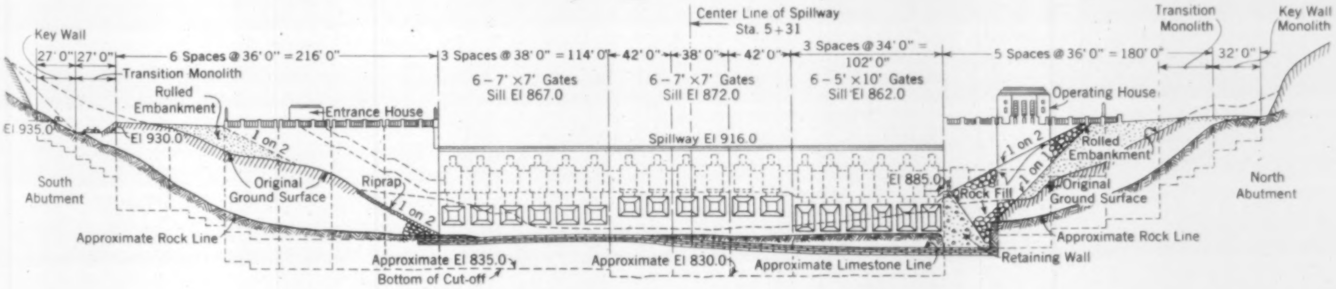

Key Wall
27' 0"
27' 0"
6 Spaces @ 36' 0" = 216' 0"
Transition Monolith
Rolled Embankment
Entrance House
El 935.0
El 930.0
1 on 2
South Abutment
Original Ground Surface
Riprap
1 on 2
Approximate Rock Line
Approximate El 835.0
Bottom of Cut-off
Center Line of Spillway
Sta. 5+31
3 Spaces @ 38' 0" = 114' 0"
42' 0"
38' 0"
42' 0"
3 Spaces @ 34' 0" = 102' 0"
6 – 7' × 7' Gates
Sill El 867.0
6 – 7' × 7' Gates
Sill El 872.0
6 – 5' × 10' Gates
Sill El 862.0
Spillway El 916.0
Approximate El 830.0
Approximate Limestone Line
El 885.0
Rock Fill
Retaining Wall
Operating House
1 on 2
1 on 1
Rolled Embankment
Original Ground Surface
Approximate Rock Line
5 Spaces @ 36' 0" = 180' 0"
32' 0"
Transition Monolith
Key Wall Monolith
North Abutment

Fig. 3. Upstream Elevation of Dover Dam

The Gates for the 18 Conduit Openings Through the Body of the Spillway Are Operated from a Longitudinal Gallery in the Dam rest of the section is being made up of random material with an impervious core, as shown in Fig. 1.

A sufficient quantity of rock is not available at the Beach City, Charles Mill, Pleasant Hill, and Bolivar dams, but there is an abundant supply of coarse pervious materials for the outer shells. The large stones are being raked toward the outside slopes, and will form a satisfactory protection against weathering, slope erosion, and wave wash. At Leesville and Mohicanville neither strictly pervious material nor durable rock are available in sufficient quantity. Instead, the outer sections are built up of random materials with riprap protection on the upstream slope. At the remaining dams, the entire embankment section is made up of impervious material with rock-fill toes and riprap on the upstream slope.

SPILLWAY AND OUTLET STRUCTURE, CHARLES MILL DAM

OUTLET WORKS AND SPILLWAYS

Due to the great variation in outlet and spillway discharges and the height of normal pools in relation to maximum flood levels, a number of types of outlet structures and spillways were found desirable. At not less than nine sites the topography is favorable for saddle spillways. These consist of a rough cut with the sides and bottom lined wherever the rock is too poor to withstand weathering.

Where the outlet discharge is large and the normal pool retained at a comparatively low elevation, a concrete weir with its crest at normal pool level was designed just upstream from the intake. Beach City and Wills Creek are examples of this type (Fig. 2). The weirs were omitted at the Mohawk and Bolivar dams as there will be no permanent pools. Six 8 by 17-ft, or 7 by 15-ft, caterpillar-type gates will be used at each of these sites, with an emergency gate of similar design to close any one opening. The service gates will be operated by individual hoists from the operating floor, while an overhead crane will be used to operate the emergency gate and the service gates at times of repair. Heavy cast-iron linings are provided for 12 to 15 ft back of the service gates to protect the conduit walls from cavitation or erosion, and all gates are thoroughly vented.

The design of the outlet works for the Tappan, Clendening, Piedmont, Leesville, and Atwood dams is in another class as these sites are to have a high conservation pool level which will be only 10 to 12 ft below the spillway elevation. These outlets resemble water works intakes. The gate design has been standardized, all gates being of cast iron $3^1/_2$ ft wide by 7 ft high, with stainless-steel stems, operated by screw hoists on the operating floor. Three gates will be used at each of these sites, except at Piedmont, where four will be required. A structural steel emergency gate, 5 ft by 10 ft, operated on two large rollers on each side, will be provided to close any of the openings. The operating houses will have overhead cranes. Cast-iron linings are provided behind the gates, and all gates are being vented.

At Charles Mill, Mohicanville, and Senecaville, the outlet works have been combined with the spillways, which consist of gravity dams discharging water on to an apron built in steps, admitting the water to the stilling basins downstream from the outlet works. The spillway crests are entirely open, with no obstructions in the form of piers or otherwise, to ensure their proper functioning in case of emergency. At Charles Mill, five openings $3^1/_2$ ft by 7 ft are provided through the spillway, and the gates, similar in design to those just described, are operated from an overhead bridge. At Senecaville two $3^1/_2$ by 7-ft gates will be installed as sluice gates in a bulkhead section, while on each side of the outlet structure there will be a $16^1/_2$ by $11^1/_2$-ft Tainter gate. A short spillway section extends on each side of the Tainter gate section. The crest of the rollway under the Tainter gates will be at normal pool level, and normally they will be left open to allow for fluctuations in the reservoir. The sluice gates will only be operated at times when a drawdown of the reservoir pool level is desired.

Pleasant Hill has a design all its own. An intake structure, located at the head of a 14-ft 3-in. tunnel, will house two $3^1/_2$ by 7-ft sluice gates of the standard design previously described. The intake will consist of a square tower 11 by 11 ft in inside dimensions and 160 ft in height from foundation to roof of operating house. To control the pool level, slots are provided in three of the intake tower walls. The water will drop vertically through these slots into a pool below and then discharge into the tunnel. The spillway will be of the morning-glory type, consisting of a vertical shaft, continuing into a tunnel 19 ft in diameter which will end in a stilling basin below the dam. The intake tunnel will connect with the spillway tunnel a short distance downstream from the elbow. A complete model of outlets and spillway works was tested at the hydraulic laboratory of the Case School of Applied Science in Cleveland.

Carefully designed stilling basins are being constructed at the outlet ends of all dams. Hydraulic model experiments for these basins were carried out at the Case School under the direction of Professor Barnes.

DESIGN OF DOVER DAM

The Dover Dam, a gravity-type concrete structure, will have a total length of 820 ft between abutments and a maximum height from the deepest foundations of about 100 ft. The height of the spillway above the average foundation level will be 70 ft and the total length of spillway, 338 ft. The spillway section will be provided with 18 conduits located at three levels in groups of six and controlled by gates. The 12 lower gates normally will be closed, and normal pool level will be controlled most of the time by the six upper gates, the inverts of which will be 2 ft below normal pool level. A stilling structure, the full width of the spillway section, will extend 187 ft downstream from the axis of the dam.

The main part of the dam will be founded on a limestone layer under which is a layer of carbonaceous shale overlying a medium hard sandstone. As the foundation formations contain horizontal strata having a low coefficient of sliding, special precautions were taken to guard against failure from this cause. Tests show that the rock is amply strong to carry any load imposed in crushing or compression; shear resistance is also ample.

At the upstream face of the dam a cut-off wall will extend through the limestone and carbonaceous shale into the sandy shale at depths varying from 12 to 18 ft. This serves the purpose of a shear wall and is included in the design calculations for stability. The connection with the body of the dam will be heavily reinforced to take all shear from the horizontal water load, and an extensive system of grouting and of drainage will be used.

In addition to the 18 conduit openings through the body of the spillway, as shown in Fig. 3, there will be a longitudinal gallery the full length of the dam, from which the gates will be operated. Owing to the difficulty of accurately predicting the stresses in the body of the dam because of these openings, tests were made on a typical section with all voids represented. The model was made of bakelite and tested in a polarized-light machine by Professor Plummer of the Case School, and the results were analyzed by him and by our own force. It was found that the stresses around openings or abrupt changes in sections were much higher than computed for an entirely homogeneous section. The photo-elastic tests revealed danger zones that would have been difficult to detect by mathematical analysis. Wherever the stresses were considered higher than should be allowed for plain concrete, these zones were heavily reinforced. The stresses in a low dam, such as the Dover Dam, are not high and the tests here described possibly could have been omitted, but it was felt that, owing to the importance of this structure, the expense was justified. The cost of making the polarized-light machine was only $85.

The dam is being built in 23 monoliths with expansion and contraction joints spaced approximately 38 ft apart. The joints are provided with keys and copper water stops, and the surface is painted with asphalt.

Various types of gates and gate control were considered and studied and the type finally adopted gives maximum free spillway length and eliminates the cost of superstructures and outside housing of equipment. The gates are of cast iron, 5 by 10 ft and 7 by 7 ft in size, and of a design similar to those previously described. They will be operated by oil cylinders with a maximum pressure of 500 lb per sq in. A motor-driven oil pump, with a capacity of 25 gal per min, will furnish oil to all cylinders, and an auxiliary pump unit will be installed for use in emergency.

Hydraulic Models Prove Their Worth

By George E. Barnes, M. Am. Soc. C.E.

Professor of Hydraulic and Sanitary Engineering, and Head, Department of Civil Engineering, Case School of Applied Science, Cleveland, Ohio

and J. G. Jobes, Jun. Am. Soc. C.E.

Associate Engineer, Los Angeles Office, U. S. Engineer Department, Los Angeles, Calif.

HYDRAULIC model studies were conducted on 11 of the dams for the Muskingum Watershed Project for the general purpose of determining what revisions in the design of the hydraulic structures might be necessary or desirable for optimum performance.

The dams themselves have been described elsewhere in detail. Dissimilarity between structures is occasioned partly by the fact that the operation of the several works is to be interrelated, and the performance of one outlet works in certain cases affects another. These circumstances result in a great variety of hydraulic problems to be solved in design. For each dam, however, the outlet works terminate in a stilling basin in which a hydraulic jump is formed.

Each model included some or all of the following elements: Topography of the reservoir in the vicinity of the control works; intake tower and gates; outlet conduits or tunnels; stilling basin; outlet channel; and spillway. The models were undistorted, to the same vertical and horizontal scale, with scales varying from 1:20 to 1:40.

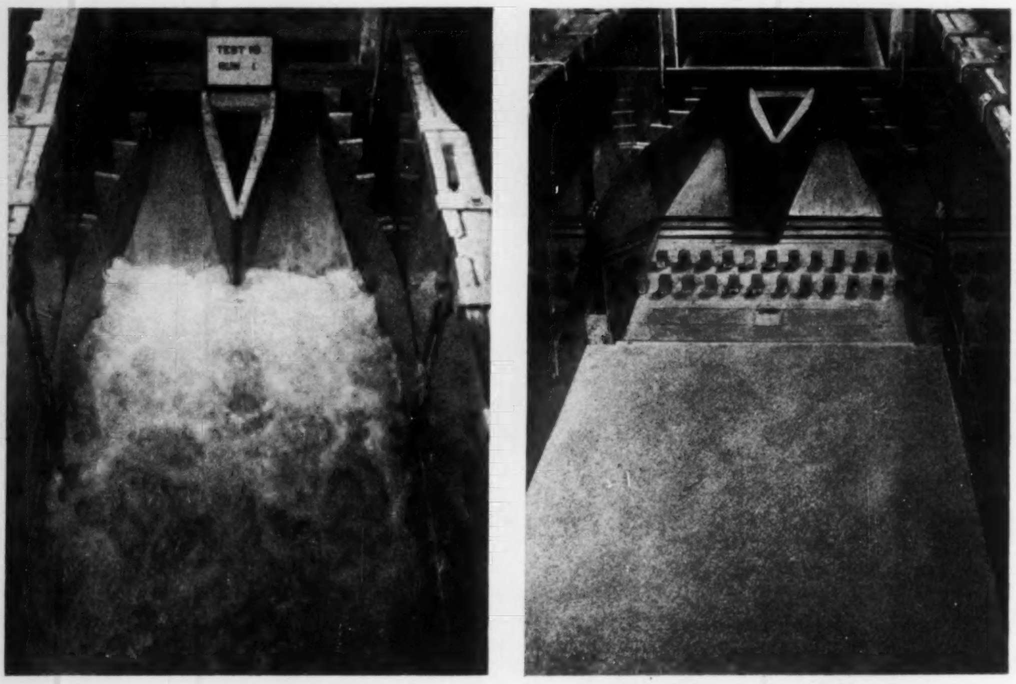
The topography of the reservoir and of the channel below the dam was reproduced in the model by an inundated sand fill topped with a $1^1/_2$-in. mortar coat. The shaping of this part of the model was facilitated by sheet-metal templets cut to the proper transverse profile and set at several stations on the center line of the works. To reproduce those parts of the hydraulic models which were most complex in shape with reasonable accuracy and speed, it was found best to use metal. The model tunnels and gate towers, therefore, were made from welded 16-gage sheet steel. The morning-glory spillway required for one model was spun from sheet aluminum, on a laminated solid wooden core, accurately turned to shape. Stilling basins were usually built with wooden floor, walls, baffle piers, and terminal sill, although where the side walls were warped, it was easier to secure proper dimensions with 22-gage galvanized sheet metal, or with flexible transparent sheets of commercial cellulose or synthetic resin. Where revisions in form were not anticipated, the walls and floor of the stilling basin were formed in mortar.

Numerous piezometer connections were installed along the floors of the conduits and at other points where pressure readings were desired.

For each of the dams the following features of operation were studied: Relation of reservoir stage to discharge, for various combinations of outlet openings; distribution of energy losses; capacity and behavior of spillways; and performance of the stilling basin, particularly as affected by variation in tailwater level at a given discharge, or unsymmetrical discharge from the multiple outlets.

On each model so-called formal tests were conducted, which included all measurements required to determine behavior under the stipulated operating conditions. Such measurements included the hydraulic gradient through the structure, the upper pool elevation, the discharge, the water-surface profile of the hydraulic jump, the distribution of velocities in the stilling basin, and the topography of scour as ascertained at the end of an hour's run.

For a record test, the sand bed below the stilling basin was first screeded level to the desired elevation. By a 2-in. flood line, water was admitted slowly at the tailgate until it reached approximately the depth corresponding to the intended discharge, so that initial scour during the run would be slight. The proper inflow was then regulated by the venturi-type meters, and the reservoir level and tailwater level were brought to equilibrium. All piezometers were blown free of air and stabilized. The hydraulic gradients were then recorded, the water surface profiles taken in the stilling basin with a point gage, and the distribution of velocities measured by pitot tube or Bentzel tube in the stilling basin and below the terminal sill in the outlet channel. At the end of an hour's run, flow was stopped, the reservoir allowed to empty, and the lower pool drained to expose the sand bed, which was then contoured with a sounding rod to record the depth and location of scour.



HYDRAULIC JUMP IN A STILLING BASIN MODEL, AND THE STRUCTURES THAT PRODUCED IT
The Flow in the View on the Left Represents a Discharge in Nature of 19,400 Cu Ft per Sec

Scour was considered to be an index by which relative performance under various conditions could be roughly compared, since it denoted concentration of high velocities or persistent eddies and whorls along the bottom of the channel. Excessive or irregular scour in any case showed poor distribution of terminal velocities. From velocities at 0.2 and 0.8 depth the discharge was computed by ordinary stream-gaging methods to check by agreement with the venturi-type meter readings.

HOW ERRORS INHERENT IN MODEL STUDIES CAN BE MINIMIZED

Mechanical imperfection of the models and the physical difficulty of taking precise measurements may seriously affect the results of a hydraulic model study if their significance is underrated or ignored. Some of these factors deserving special consideration are the following:

1. Discharges. The small ratio of flow in the model to that in the prototype necessitates accurate measurement of discharge. Where a weir is used, calibration should be direct, by volume or weight if possible. Otherwise precautions must be taken to ensure that the weir corresponds in setting to the original from which the formula was derived. With the venturi-type meter, the direct reading from ordinary differential manometers can be used in the neighborhood of full capacity, but with lower flows it is much more satisfactory to magnify the deflections of the manometer by the use of a lighter liquid, such as carbon tetrachloride. The specific gravity of the tetrachloride must be carefully and frequently determined, and the glass tube should be at least $^1/_2$ in. in diameter to permit easy cleaning and to avoid the effects of surface tension on the meniscus.

2. Piezometer readings. Where there are high velocities, piezometer readings are the most difficult measurements to obtain accurately. A smooth $^1/_8$-in. hole, with a $^1/_{16}$-in. radius free of burrs is suggested by Prof. C. M. Allen, M. Am. Soc. C.E., in his paper entitled "Piezometer Investigation," in the *Transactions of the American Society of Mechanical Engineers*, for May 15, 1932. As the relation between discharge in the prototype and that in the model depends on the ratio of n for the two, and since n must be determined by piezometer readings, the importance of accurate readings and the care that should be exercised in the fabrication of piezometer connections cannot be over-emphasized. It should be remembered that piezometers record pressure and not water depth where curvilinear flow exists in a vertical plane. Of all the measurements taken, the piezometer readings were the most difficult and the least satisfactory.

3. Orifice coefficients. The use of models in which orifices are involved brings up the question as to how the coefficients are affected by actual size. Tests covering small orifices show a variation in the coefficient with the actual size of the opening.

4. Joints and connections. A model should be constructed with as few joints as possible, for joints affect flow conditions both upstream and downstream and cause breaks in the hydraulic gradient that are apparent in the piezometer readings.

5. Warping. Prevention of warping of wooden models is extremely difficult, but a slight warping is often sufficient to produce incorrect flow conditions that seriously affect the results. Among the many methods of waterproofing tried by various hydraulic laboratories may be mentioned the use of celluloid dissolved in banana oil, and the use of aluminum foil—both by the Iowa Institute of Hydraulic Research.

6. Settlement. Settlement of the sand base under mortar surfaces leaves the templets exposed and puts the surface elevations in error. If the sand base is thoroughly inundated prior to placing the mortar surfaces, and is kept wet, this difficulty is minimized.

7. Velocity measurements. Velocity measurements may cover a wide range from well below 1 ft per sec to above 10 ft per sec. For low velocities, the Bentzel velocity tube, specially constructed pitot tubes, and small current meters have all been used by the various laboratories.

8. Entrained air. Hydraulic formulas based on water at $62^1/_2$ lb per cu ft do not hold exactly for the hydraulic jump or for the flow of water in which air is entrained. In designing any structure in which such flow conditions exist, a factor of safety should be added to the minimum dimensions shown by the model tests.

IMPORTANT IMPROVEMENTS MADE IN DESIGN OF STILLING BASINS

The following observations apply to the models studied for this project, and no broad generalizations are attempted. The outstanding single result of the Zanesville tests was an improved design of all stilling basins. Where there were single- or twin-outlet conduits, with the jet issuing from the portals between flaring side walls over a curved apron, the models demonstrated that the jump could be held on the apron with slight change in location, for all rates of discharge and corresponding tailwater levels, by block-shaped baffle piers with stepped up-stream face, anchored to the basin floor.

Excessive flare and batter of the side walls caused poor lateral distribution of the shooting flow on the apron, with whorls, eddies, and concentrated high velocities at the exit from the basin. Similar behavior accompanied the presence of excessively high tailwater in any case. A low average velocity computed on the basis of high tailwater proved to be a deceptive index to flow conditions, if the jump itself was neither positive nor balanced.

The outlet tunnels for several of the dams were set so low that good performance at certain rates of discharge was impossible with the original design. To secure a good hydraulic jump without raising the tunnel, the proper relation between momentum of outflow and tailwater depth was secured by passing the water over a humped apron through which a narrow gutter was cut for drainage.

In all stilling basins the tailwater stages were such that a floor elevation in the basin much below the elevation of the stream bed was in general found to be needless, and the model studies usually resulted in reducing the design length or width of the basins, or both. Liberal size of basin, alone, was found to be an insufficient guarantee of adequate performance.

The true head between reservoir and outlet is difficult to discover. For the preliminary designs, outflow computations were predicated on head measured as reservoir elevation minus portal invert elevation minus the average depth of flow at the portal. Actually, the head will be greater than this, since the pressure head on the apron is less than that caused by an equal depth of still water. The discrepancy between assumption and fact will depend on sharpness of apron curvature and jet velocity. In the case of the Pleasant Hill model, the true head by piezometers appeared to have a value closer to reservoir elevation minus portal invert elevation minus half the depth. The model discharge was greater than anticipated, and in fact substantially exceeded the required capacity, so that the original diameter of 20 ft for the tunnel and shaft was reduced to 19 ft—a change which appreciably reduced the cost of construction.

To check the stipulated capacity of the outlet works at a given reservoir stage, it is necessary to convert the model discharge into corresponding flow in the prototype. Where gravity is the predominating factor inducing flow, with comparatively slight retardation from friction, the flow in the model is directly converted to flow in the prototype by the $^5/_2$ power of the scale ratio. For long tunnels, however, where frictional retardation has a large influence on discharge, the ratio of n in the model to that in nature must be taken into account. In the models studied, too much confidence in the experimental values of n is not warranted, because the model tunnels are believed to be too short for the proper measurement of this factor.

EXPENDITURE FOR MODELS WAS JUSTIFIED

The fact that hydraulic models cannot be made to reproduce exactly in miniature all the phenomena that will occur in the prototype does not detract from their utility. The performance of hydraulic models may be interpreted to great advantage by a designing engineer. At Zanesville the model studies were helpful in expediting the production schedule demanded of the design staff, by contributing a valuable supplementary method for attacking complex problems of hydraulic design. The tests more than saved their own cost by reducing construction expenditure. More than this, they have given invaluable assurance as to the probable behavior of the works now building.

The model studies were made in the Warner Hydraulics Laboratory of the Department of Civil Engineering, Case School of Applied Science, in Cleveland, Ohio, under the direction of the author, with J. G. Jobes, co-author, then Associate Engineer and Chief of the Hydraulic Models Subsection, Zanesville District Office, U. S. Engineer Department, as assistant in active charge of the prosecution of the model work.

Problems of Railroad Relocation

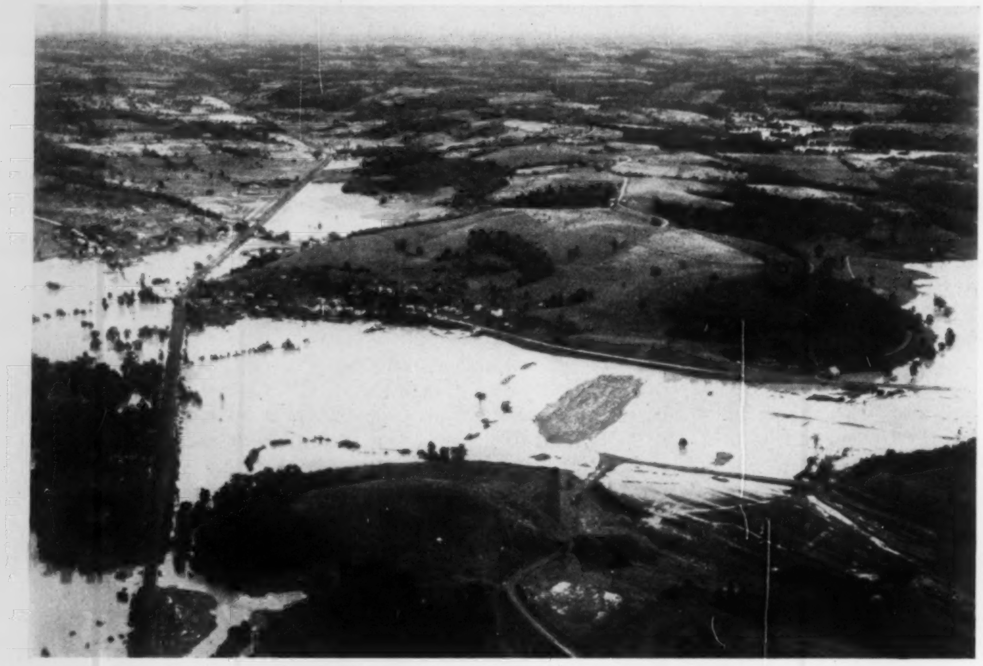
By Gilbert H. Friend

Member American Society of Civil Engineers

Senior Engineer and Chief of Railroad Section, U. S. Engineer Office, Zanesville, Ohio

In addition to the attractive grades that the valleys of the Muskingum watershed have offered in the past for the construction of railroad lines for the handling of through traffic, the territory is rich in mineral resources, chiefly coal and ceramic clays. The development of these resources called for the construction of many branch lines and feeders, and as a result, the entire watershed is a network of railroads. These include main lines and branches of the Pennsylvania, the Baltimore and Ohio, the Erie, and the Wheeling and Lake Erie systems. The expense of relocating the railroads had an important bearing upon the selection of sites for the dams and reservoirs that were finally adopted as part of the official plan of the Muskingum Watershed Conservancy District.

Studies for railroad relocations were begun May 1, 1934, and were continued until August 1, 1934, before surveying parties were placed in the field to run preliminary lines and final locations. During that period, estimates were prepared on more than 280 miles of railroad relocation. The work was done at top speed. The planning section studied 151 different dams and reservoir locations during the period, and in some instances, studies were made for four or five different spillway elevations for one particular dam. In every instance, the railroad section was required to answer promptly the questions, "What railroad lines, if any, will be affected?" and "What will it cost to relocate them?"



STILLWATER CREEK OVERFLOWS PIEDMONT DAM EMBANKMENT

The Railroad Right of Way Survived This Flood

There was not time in the short 90-day period to run preliminary lines. As a basis of estimating, suggested grade lines were outlined upon enlarged U. S. Geological Survey topographic maps. The alignment of tangents and curves was projected to fit the grade lines as closely as possible; profiles were picked off from the contours; and grading quantities were then estimated. This information was augmented by information obtained by hurried reconnaissances made by automobile. The estimates thus prepared remained unchanged, and the budget of expenditures was based upon them until bids for construction were received.

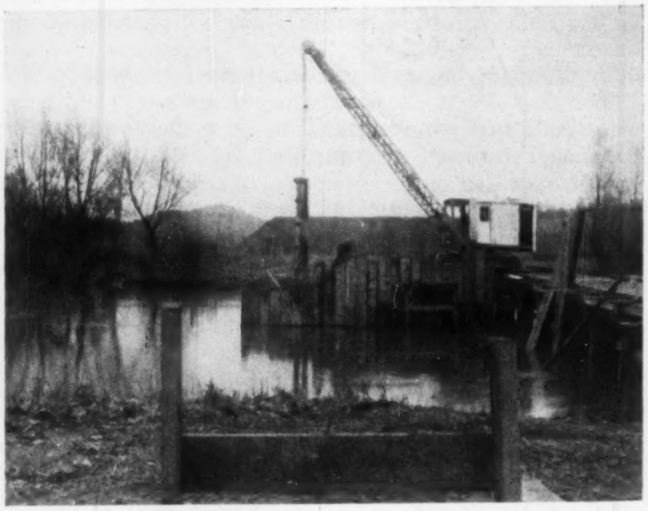
NEARLY 70 MILES OF TRACK TO BE RELOCATED

The official plan, as finally adopted, requires the relocation of 52.17 miles of railroad main track and 16.64 miles of sidings, a total of 68.81 track miles. A total of 12.91 miles of trackage will be relocated for the Pennsylvania Railroad; 17.2 miles for the Baltimore and Ohio; 5.4 miles for the Erie; and 33.3 miles for the Wheeling and Lake Erie.

The work is being performed by contract, except where the raising or cutting in of existing operated tracks is involved. At such locations the work will be performed by railroad company forces at a cost to the federal government previously agreed upon. The contracts generally include all work of construction with the exception of the fabrication and erection of the major steel bridges, awarded under a separate contract. The total estimated cost of taking care of the railroads on the entire project is approximately $6,000,000.

In two instances, it was determined that certain lines of railroad had practically served their terms of usefulness. Agreements were entered into with the owning companies with a view to securing authority from the Interstate Commerce Commission for their abandonment. In another instance, where two companies now have parallel lines with a combined traffic that can readily be handled by one line, arrangements are being made to relocate only one line, to be jointly owned and operated. It is fitting to state that the railroad companies have joined in the undertaking in a markedly cooperative spirit.

In relocating the lines it is the policy of the District to construct them to standards of quality at least equal to those of the existing lines. In the matter of track construction, the standards of the railroad being relocated have been adopted throughout. In bridge and masonry design an effort has been made toward uniformity on all railroad relocations for the sake of economy. The larger drainage openings are of the reinforced concrete box type, and bridge abutments are of the open-frame type. Deck plate-girder spans up to a maximum of 125 ft in length, designed for Cooper's E-60 loading, have been adopted for major bridges, with one exception.



DRIVING PILES FOR BRIDGE PIER COFFERDAM, MOHICAN RIVER

A Pennsylvania Railroad Relocation, Mohawk Reservoir

Every railroad bridge engineer has individual ideas concerning various features of design, which he desires to have carried out. Some of the features required by one railroad bridge engineer are not approved of by another. It has been an interesting task to bring about reasonable uniformity in bridge and bridge masonry design for the entire project, and here again, the railroad bridge engineers have cooperated by yielding a point here and there as seemed desirable.

Baltimore and Ohio Relocation, Beach City Reservoir
Constructing Cofferdam for Bridge Pier

The American Railway Engineering Association has adopted standards for the design of certain railroad materials and appliances. It is interesting to note that in regard to such a simple appliance as a track spike, each of the four railroads whose lines are being relocated has its own standard design, differing in some slight detail from the others. Furthermore, each of these railroads uses a different arrangement and a different number of spikes for fastening the rails to each tie. One railroad uses four 1-in. bolts for each rail joint, another uses six. Such differences in practices and standards exist throughout a long list of materials and appliances used in railroad relocation work.

PLANS AND SPECIFICATIONS MUST BE COMPLETE

When a new line is to be constructed it is customary for the railroad to furnish the bidders with a profile of the location and general specifications covering materials and workmanship. The details of design of bridges, buildings, and other structures are worked out after the contract is awarded. But this practice cannot be followed when work is to be performed under a government contract. Then the plans and specifications must be complete to the most minute detail.

It has been the practice, when plans and specifications are prepared, to submit them to the railroad companies for review and approval before the work is advertised for bids. Aside from the great amount of investigation required to obtain the necessary data to ensure that tracks and other facilities, requiring renewals and the carrying in stock of repair parts, conform with the owning company's standards, there have been no unusually difficult features involved in the work.

The Conservancy Act of the State of Ohio provides that in the relocation of railroads, the ruling grades on the operating division affected must not be exceeded. This requirement has been fully met without difficulty. It has been the aim not to increase distance and curvature when laying out relocations. In one or two instances, this was not physically possible, but in most cases distances and total degrees of curvature have been decreased rather than increased.

COMPACTING EMBANKMENTS IS AN INNOVATION IN RAILROAD CONSTRUCTION

At the beginning of the negotiations, the railroad companies were inclined to stress claims for "extraordinary maintenance" due to being required to maintain newly constructed roadbeds. The grounds for these claims have been to a great extent removed by requiring that the embankments shall be constructed in 1-ft layers and each layer thoroughly compacted either by rolling with an approved type of power-driven roller or by tractor haulage and spreading equipment. In general, tractors, tractor wagons, and bulldozers mounted on tractors have ensured excellent compaction without the use of special rollers. This requirement for the compaction of embankments is an innovation on railroad construction work. It has been demonstrated that the requirement has not tended to materially increase the bid prices, whereas the benefit in respect to future maintenance will be very great.

For many minor stream crossings an economy in construction has been obtained by the development of a metal-encased reinforced-concrete pile trestle with heavy-section H-beam superstructure, in lieu of longer girder spans supported by massive wing abutments. The trestles are designed with spans up to 30 ft in length. The abutments are formed of concrete piles driven in the end slopes of the abutting embankments supporting reinforced concrete bridge seats and back walls.

Relocation of Highways in the District

By Charles E. McKee

Engineer in Charge, Muskingum Watershed Conservancy District, Division of Planning and Design,
State Highway Department, Zanesville, Ohio

On July 18, 1934, the director of the Ohio State Department of Highways entered into an agreement with the Muskingum Watershed Conservancy District to relocate all roads, highways, and streets within any reservoir sites of the District, as set forth in the official plan; to acquire rights of way incident thereto; and to provide ingress and egress to all property owners affected.

To cooperate with other agencies at work on the project and to formulate the necessary plans, the highway department established an office in Zanesville last February. Until that time, owing to indecision as to which reservoirs would be built, no comprehensive survey had been made of the highway situation. Work was started immediately to formulate a complete highway layout for each basin, and to prepare the necessary plans, so that construction might proceed simultaneously with other work in the District.

COLLECTION OF DATA

We first prepared a compact map of the District, showing the reservoir layout superimposed upon the state highway system. Next, we prepared small reservoir key maps, each showing a complete reservoir on a single sheet, to a scale of 2 in. to the mile, with such adjoining territory that a complete highway picture was available. On these key maps was plotted all construction in connection with the project.

For easy identification, the various county and township roads were given three-part designations by taking the first two letters of the basin name, the first two letters of the county name, and a numeral, the road nearest the dam site receiving the numeral one. For instance, Se-Gu-1 designated a road in the Senecaville Reservoir, Guernsey County, at the dam site.

TEMPORARY RELOCATION OF ROUTE 8, DOVER RESERVOIR
Showing the Underpass Beneath the Relocated Right of Way of the Wheeling and Lake Erie Railway

A condition survey was then made of all roads within a one-mile radius of the basin, and reports compiled giving the widths of metal, roadway, and right of way; use of road, that is, access to farms, mail routes, or school bus routes; traffic count; log of critical points affected by the formation of the reservoir; and present frequency of flooding.

After collecting this mass of data we were able to proceed on a comprehensive plan. A rough estimate indicated that if all roads within the basins were relocated and raised to an elevation above spillway crest, the original $4,000,000 estimate of the cost of the work would be greatly exceeded. Accordingly, a general policy was formulated, based on the necessity of the work, and only roads that came within the following general classifications were considered:

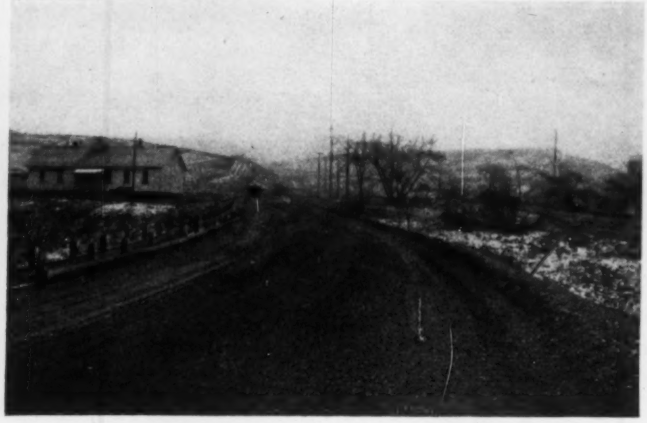
1. Roads displaced or intercepted by the actual construction work of the District.
2. Roads intercepted by the permanent pools in the conservation basins, but which must be retained as part of the state, county, or township systems.
3. Roads necessary for access to property.

Approximately 150 miles of road comes within these limits. In addition, there will be numerous access roads which it will be impossible to plan until final disposition is made of the villages and residences within the flooded area. The estimated cost of this work is $6,500,000, including engineering and right of way.

DESIGN OF ROADWAY STRUCTURES

The second phase of the work has been the design of the roadway structures. This necessitated the determination of the elevations at which the roads should be placed to furnish reasonable service to traffic during periods of flood. Railroads and other public utilities in the flood areas have been relocated 2 ft above spillway elevation, but this policy is economically impossible with highways. A study of the effect of the lesser floods with the reservoir system in operation was made from curves furnished by the District, which indicated the frequencies of flooding at various elevations below spillway levels in accordance with the proposed methods of operating the reservoirs. Since these curves were necessarily prepared on a conservative basis, we used only three points on them as decisive in the design of highway structures:

1. The one-year flood elevation, held as a minimum for secondary replacements.
2. The elevation where the valley broadens and storage capacity is great in proportion to the depth, selected as a minimum for state highway replacements.
3. The spillway elevation.



RELOCATION OF NEW PHILADELPHIA–ZOARVILLE ROAD, DOVER RESERVOIR
Double Guard-Rail Feature Is to Protect School Children

There was a marked similarity in the curves for the various types of basins, which has allowed them to be grouped into the following three classifications.

ROADS IN BASINS WITH LARGE CONSERVATION POOLS

In the first group are included basins in which pools are maintained at a depth of from 20 to 35 ft, and in which there is little difference in elevation between the permanent pools and spillways. These include the Senecaville, Piedmont, Clendening, Tappan, Leesville, and Atwood pools, all situated in comparatively narrow valleys in the upper drainage areas. The topography is rugged and the sides of the valleys rise abruptly from 200 to 400 ft above the floors. These valleys are traversed lengthwise by principal highways, fed at frequent intervals by crossroads. Crossings of these reservoirs have been avoided wherever possible, and roads have been carried around the edges to connect with the county and township systems. Access to adjacent property is best provided in this manner, and property damages which result from creating dead-end roads are avoided.

The relocation of secondary roads in these basins has proved an expensive problem, as water covers the natural locations and the only alternative is to cut a roadway into a rather unstable hillside. Whenever possible, curvature has been introduced into these alignments to avoid fills within pools. On state highways, however, the use of the latest standards of alignment and a 1,000-ft minimum sight distance has necessitated the construction of high embankments through the pools, with protection from wave and ice action.

Embankments through pools consist of a rolled section and an outer shell of loose dumped rock having a minimum depth of 3 ft and extending 5 ft above permanent pool level. In the design of these embankments we have used unclassified material from roadway excavations, specifying a random fill and using shale, rotten stone, and earth to the best advantage to secure a dense section. Core and auger borings are taken of all cuts where the material is to be used through the pools or flooded areas, but no attempt is made to classify the material, except for the purpose of design. The selective placing of the rolled embankment is thoroughly covered by specifications which permit the use of no solid material greater than 6 in. in diameter, due care being exercised to see that voids are filled with earth. The angle of repose of the earth is determined in the laboratory. In some basins where no large amount of rock fragments is found, it has been specified that earth fills should be compacted with the optimum content of soil to secure maximum density and a more impervious section.

Pavements placed on embankments through permanent pools will have flexible stabilized surfaces from 6 to 9 in. thick. Secondary roads are being built with a minimum width of 20 ft and 14 ft of surfacing material. More important county roads are designed with a minimum roadway width of 24 ft in cut and 26 ft in fill, with 18 ft of surfacing material. Timber bridges, designed for a H-12 loading, will be used in all places except villages. Culverts of corrugated iron pipe or reinforced concrete, without headwalls, are used throughout. Standards of grade and alignment are made consistent with those now existing on other parts of the road, but in anticipation of a considerable increase in traffic where permanent lakes are formed, preference has been shown for a higher type road than now exists.

The greater part of the secondary highway work on the entire project is in these basins. A total of 78 miles of road work will be required in this group, at an estimated cost of $2,308,200.

ROADS IN BASINS WITH NO CONSERVATION

The Mohawk, Mohicanville, and Bolivar basins make up the second group, which comprises basins in which there will be no conservation pools. Here the variation in flood height for the most frequent storms is very pronounced, and to raise all roads to such a height that they would be flooded no more frequently than at present would be not only impossible from a financial viewpoint, but also inadvisable from a practical analysis of the needs of the situation. Some question still remains as to the final disposition of the residences and villages within these basins; new avenues of travel will be needed and old ones discarded when the people are rehabilitated. It is probable that the existing roads will remain in use until replacement is required due to wear. At that time more data will be available concerning the operation of the reservoir system, and a more intelligent solution of the problem can be reached.

No effort has been made to reconstruct secondary roads except where they are intercepted by other construction activities. State highways that would be subject to frequent flooding are preferably being relocated entirely outside these basins. Where this is impossible, a height insuring approximately only a 20-year frequency of flooding is maintained. The embankments through these basins consist only of a rolled section, designed in the same manner as described for the first group. No side-slope revetment is used except at stream crossings.

The work in these basins comprises 33 miles of road construction at an estimated cost of $1,264,000.

RELOCATION OF ROADS IN BASINS WITH SMALL CONSERVATION POOLS

Five basins are included in the third group, comprising those with relatively small conservation pools. These are Beach City, Charles Mill, Dover, Pleasant Hill, and Wills Creek, which combine the problems of those included in the first two groups. Owing to the small flood storage at the lower elevations, fluctuations in flood heights are very pronounced. The one-year flood averages 6 ft above permanent pool elevation, and the two-year flood, 11 ft.

A few secondary roads are intercepted by the pools, but these are relatively unimportant, and at present are generally flooded at least once a year. Due to the wide spread in the flood heights mentioned, replacements have been made at the minimum elevation of 2 ft above the one-year flood. State highways have been placed at flood heights varying from the 10-year to the 20-year storm, depending upon the importance of the road and the availability of material for embankments.

Most of the major railroad relocations are in this group and necessitate the greater part of the highway work. The problem of flood heights is relatively unimportant because these roads for the most part are already located where they will be reached by the less frequent floods. Relocation would make them relatively higher inside the basin than they are outside it. The work in this group covers 47 miles of road construction at an estimated cost of $2,165,400.

Tentative plans are available on all relocations and have been submitted to the Conservancy District for adoption as a part of the official plan. The program contemplates the distribution of construction over a three-year period, with completion in 1937. As of October 1935, 11.5 miles of highway, costing approximately $200,000, had been completed or placed under construction. The entire 1935 program includes 34.8 miles, estimated to cost $1,675,000 which will be advertised for bid letting prior to January 1, 1936. The 1936 program will be somewhat larger, and the 1937 program will be approximately the same as that for 1935.

Public Utility Changes

By Oliver W. Gatchell

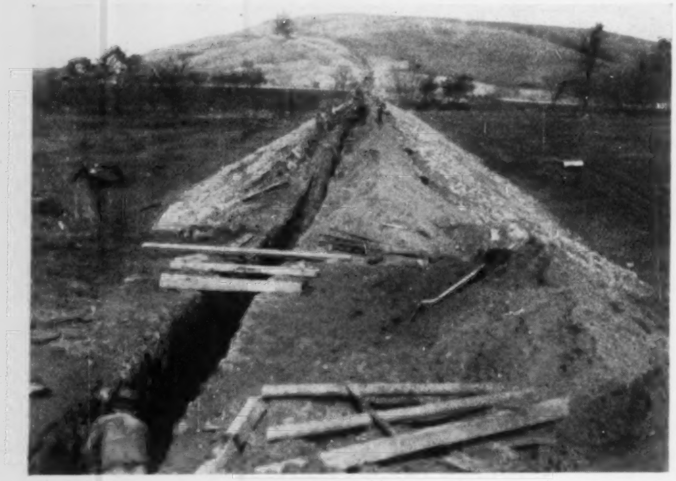
Chief, Public Utility Section, U. S. Engineer Office, Zanesville, Ohio

At the inception of the studies for the official plan of the Muskingum project it was apparent that the public utility work was sufficient in extent to require detailed examination. The utilities included telegraph lines, open wire and cable telephone lines, low- and high-voltage electric lines, and oil- and gas-pipe lines. The public utility section accordingly began work in May 1934, and after the adoption of the official plan, developed the final plans in cooperation with the companies affected.

In the early stages, utility maps were lacking and preliminary estimates were prepared under pressure in order to determine whether the utility changes were a controlling feature in the selection of a particular reservoir site, and to include the utility costs in the broad economic comparison of the different sites. This early lack of maps was soon remedied by field reconnaissance, the piecing together of company maps, and outline locations by utility survey crews. Within 60 days after the beginning of the work, utility estimates were furnished on some 100 different reservoirs.

TYPES OF WORK INVOLVED

Utility changes were not determined by natural topography alone but were designed to accommodate all related project features. Pole-line design alternates include raising or strengthening of structures, or relocation of the line. Pipe-line alternates include anchoring, reworking, or manifolding, or relocating the line to secure a better stream crossing. Determining factors in design of a line are its importance, its distance from the dam, flooding frequency, and availability of proposed highway fills. The utility design also conforms to the type of reservoir crossed. The type of reservoir with a permanent storage pool presents a somewhat different problem with respect to a utility crossing from that of a reservoir without a pool. In many instances the design for the utility changes was influenced by related features of the project such as the nearby location of a dam, railroad relocation, or levee construction. Local lines are directly affected by the state highway relocation program and the Conservancy District's disposition of nearby residents.

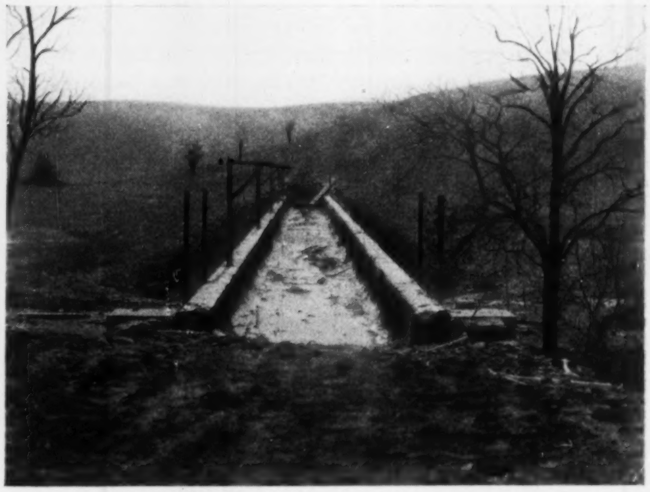


PLACING AN 18-IN. PIPE LINE ON AN EMBANKMENT ACROSS THE TAPPAN RESERVOIR

The Embankment Was Built Solely to Carry Two Gas Lines

From a dollar standpoint, the public utility work amounts to about one-tenth of the total government construction. Changes of various types are required on approximately 78 miles of pipe lines and 272 miles of pole lines, divided among 104 different utility jobs. The scope and diversity of the changes can be illustrated by naming some of the companies concerned. The electric companies include Ohio Power, Ohio Public Service, Central Ohio Power and Light, Paint Township Power and Light, and the Reserve Power and Light. The telephone companies include the American Telephone and Telegraph Company, Ohio Bell, Ohio Associated, Ohio Standard, Ohio Community, Star Telephone, and 12 rural companies. The Western Union and the Postal are the telegraph companies. The oil companies include Tide-Water Pipe, Illinois Pipe, Buckeye Pipe, and Pure Oil; and the gas line companies are the East Ohio Gas, Ohio Fuel Gas, and Natural Gas Company of West Virginia.

Utility changes are most extensive at the Atwood, Beach City, Bolivar, Dover, and Tappan reservoirs. Among these changes may be mentioned the five-mile relocation of the Philo-Canton double-circuit 132-kv line of the Ohio Power Company at the site of the Dover Reservoir, north of Zoar; also the relocation, south of the Atwood Dam, of the 18-in. and the 20-in. line of the East Ohio Gas Company, having a peak pressure of 250 lb per sq in., as the axis of the dam falls squarely on the existing lines. These same gas lines cross the Tappan Reservoir five miles above the Tappan Dam and follow the basin for a distance of approximately two miles. The relocation provides a basin crossing only 1,300 ft in length with the lines carried on an embankment and bridge, as compared to the existing two-mile crossing. The bridge and a part of the embankment referred to are shown in the photographs.



CONCRETE BRIDGE FOR GAS LINES, TAPPAN RESERVOIR

This Bridge Carries the Pipes Over a Water Passage at the End of the Embankment Shown in View at Upper Left

The Cleveland-Cambridge aerial cable line of the American Telephone and Telegraph Company is to be relocated where the line crosses the southern arm of the Beach City Reservoir at South Fork. The spans will be carried on steel towers dismantled from the 132-kv Ohio power line at the Dover relocation. The Chicago open wire toll line of the American Telephone and Telegraph Company, which crosses the Charles Mills basin, is being relocated with long-span construction at the water crossings. Nearby circuits of three other wire companies that require relocation are being carried jointly at the long spans, and this route was also used for the relocation of a high-pressure oil line of the Tide-Water Pipe Line Company, thereby effecting a reduction in the right-of-way expense to the Conservancy District.

CONSTRUCTION METHODS

No single method of construction will fit all 104 utility jobs. Construction is going forward by government contract, by hired labor, and by company forces. Government contracts, although less than ten in number, account for approximately 60 per cent of the total dollar value of the utility construction. They have been practical where the line relocations are large in extent and where the new work is sufficiently removed from the existing lines not to interfere with operations.

Many of the line changes are limited in extent and widely scattered in location. Jobs of this type require raising a few poles, relocating a mile or so of line, or clearing of line right-of-way, and are being handled in part by two hired labor gangs equipped with tool trucks working out of the Zanesville District office.

After the relocated lines are installed, the connections to existing lines are made in every case by the regular forces of the utility companies. In some cases, a company has preferred to install the new construction as well as to make the tie-ins, and this work is handled by agreement with the company.

As a result of the utility work, a worth-while amount of map information relative to the location of important utility lines has been obtained. This is comparable to the data on railroad lines which has always been shown on the U. S. Geological Survey quadrangle sheets, and should be recorded in a permanent form available to all.

Construction and Control of Earth Dams

By E. McD. Moore

Member American Society of Civil Engineers

Chief Embankment Inspector, U. S. Engineer Office, Zanesville, Ohio

In deciding upon the type of dam to be built at a given site within the Muskingum basin, the kinds of material locally available were a determining factor. Generally the excavations are found to be in disintegrated shales and sandstones in the overburden, underlain by shales and sandstones in place. The borrow pits yield a variety of materials, including disintegrated shales and sandstones, alluvial materials from shales and sandstones, and, at least at three or four of the sites, glacial tills or glacial outwash. All these materials, except the glacial outwash, are composed largely of fine sizes—silts and clays—and the upper 2 to 8 ft of the glacial outwash is also preponderantly fine.

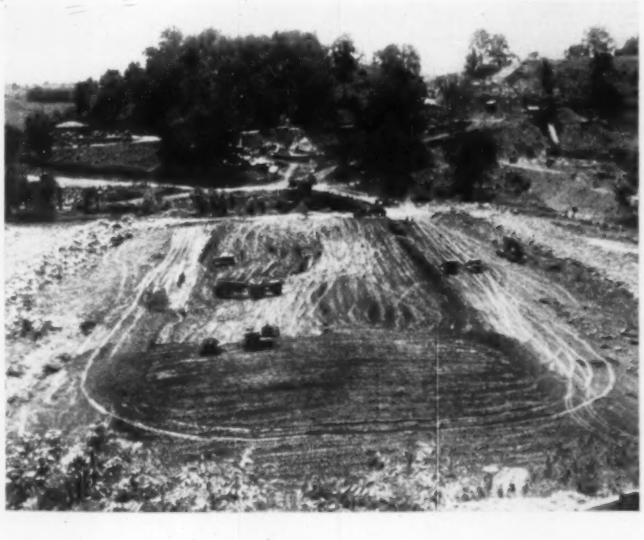
This percentage of fine sizes led to the selection of the rolled-fill type in all cases except at Bolivar. Here a number of factors entered, some favorable to the rolled-fill type and others favorable to the hydraulic-fill type. It was felt that each contractor might have had experience and equipment which would make him favor one or another type of embankment. So it was considered advantageous to set up the plans and specifications in such a way that the successful bidder could select whichever type he preferred. Thus it happened that the low bidder usually selected the rolled-fill type.

Variations in the kinds of rock in the dam excavations probably had a greater effect on the design of the sections of the different dams than did any other factor. Where good native sandstones were to be obtained, heavy rock shells of free-draining materials were used; while if the available rock was generally shale, the rock shells could not be used, and in several cases sandstone had to be borrowed for riprap.

In addition to the drill holes and test pits put down in the dam sites themselves, some 25,000 ft of auger holes and 800 ft of test pits were found necessary in investigating borrow pit areas. From this information, estimates were made of the yields of the different types of materials, and the sections of the dams were designed accordingly. In general, the embankments have a free-draining pervious shell and a highly impervious inner section. The usable materials from the excavation were placed or allocated, in any given dam, before the borrow pits were called into service.

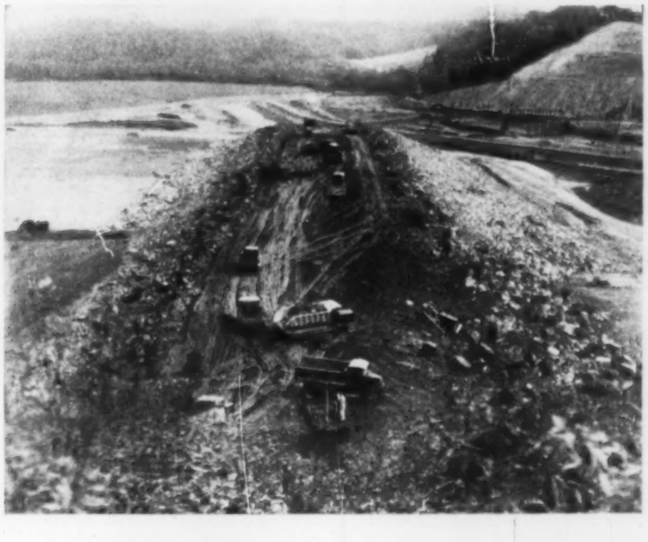
CHOOSING IMPERVIOUS MATERIAL

The impervious sections of the embankments and blankets come from the clay-carrying earths. In this region embankments carrying a high percentage of shale have been found most satisfactory. Their behavior under watering and rolling is interesting—the water softens the outer parts of individual fragments and the surface is covered with a film of clay. Bulldozing and rolling further break up the material and crowd the fragments together so that the entire mass is actually ce-



Compacting Embankment, East Abutment of Clendening Dam

The Material Is Spread in 6-In. Layers by Bulldozers, Then Compacted with Sheepsfoot Rollers Loaded to Weigh 1,000 Lb per Ft of Length



Embankment for Mohawk Dam

The Central Part or Crown of the Fill Is Carried up Ahead of the Outer Slopes so as to Give 4 Per Cent Grades, Insuring Rapid Runoff mented together. With some types, it has been found better to bring into the embankment some of the clayey earth along with the shale and spread and bulldoze the two materials together.

It is not advisable to construct the entire impervious section of shale, and in all cases some part is being made of the usual materials. Usually embankment with high shale content weighs more than 135 lb and often more than 140 lb per cu ft. This is about 10 lb heavier than the usual earth materials. The stability of the shale embankment, however, is much greater, and it has the water-tightness of clay.

General View of Embankment Operations at West Abutment of Mohawk Dam

For the impervious section of each embankment, a weight per cubic foot for different loads has been established by the laboratory. This weight was determined by placing samples of the embankment materials in consolidometers and subjecting them to the load they would be under at various depths in the embankment. Using the weights, under these loads, of the consolidated samples after they became stable, a curve showing the effect of height of embankment on weight was prepared for each embankment, by which curve inspectors could control the weight of the embankment materials at various elevations.

The pervious parts of the embankments are of sandstone, gravel, and sand. Where supplies are limited, care has been taken to place these materials in the particular parts of the embankment where it is believed they will do the most good. At one of the sites a horizontal layer some 3 ft thick has been placed about 8 ft above the base and intruding about 30 ft into the dam from the downstream face. This section, extending for the full length of the high part of the dam, allows any percolating water to pass down into it and onto the toe rather than to saturate the downstream slope.

Most of the excavation is being done with shovels averaging $1^3/_4$ yd in size. Probably Diesel power is the most popular. There are also some four or five elevating graders working in borrow pits. Various hauling equipment, including trucks and side-dump, caterpillar-tread wagons, and others, are in evidence.

SOME DETAILS OF CONSTRUCTION

At the start of each embankment, the original surface is stripped of vegetable matter, is plowed or roughened, and then rolled. The same method is followed when new embankment is placed on or against the old, as when closing sections are being constructed. Where openings have been left, as for streams, the end slopes are kept as flat as 1 on 3, or flatter, and as new embankment comes against the old, the old and new are bulldozed together and any dry material is bulldozed off, so that the surface on which the new material is placed is in the moist condition typical of rolled embankment.

When an embankment is started, the central part is built up ahead of the outer slopes, so that a crown can be established as soon as practicable, to afford rapid runoff for rainwater. This crown is generally carried high enough to give about 4 per cent grades both ways from the center line. The crown then drains off faster than do the borrow pits and the roads to the embankment, except on freshly dumped or uncompacted material. To keep rainwater from ponding on an embankment, it is better to dump from the center to the sides rather than from the sides to the center.

Before new material is brought on an embankment, the surface of the last layer is wetted and, if the new material is rather dry, water is hosed into the material as it is dumped. It is not a good plan to wet the material after it has been dumped, as this results in spots that are too wet. The materials from excavation are generally damp, and the amount of water added probably does not average more than 2 to 4 per cent. In the early morning very little water has to be added, but in the afternoon of summer days much more is required.

CONSOLIDATION IS IMPORTANT

After the material is dumped, it is spread by bulldozers in layers approximately 6 in. thick and then compacted with sheepsfoot rollers, loaded so as to weigh 1,000 lb per ft of length. In general, six passes of the roller are made and very rarely have more been necessary.

Equipment used in placing the material does a considerable part of the compacting. Equipment is kept from tracking as much as practicable, so that the whole embankment gets its share of the benefit of this consolidation. The top layer is not rolled to its ultimate expected compaction. In the first place, it is not desired to have the top of a layer so solid that the next succeeding layer fails to make a good bond; secondly, it seems probable that the old layer takes up a considerable part of the water which is hosed on it just ahead of the new layer, and that the top 2 or 3 in. of the old layer and the bottom 2 or 3 in. of the new layer are the parts that are actually wetted. The amount of water needed for shale is much more than for the usual earth, particularly if the shale is dry when excavated. In some cases it is probable that water to an amount as much as 10 per cent of the dry weight of the shale must be added.

In rolling a material that is sticky, no compaction is secured, but occasional rolling on a layer that is too wet, from rain or any other cause, helps to dry it out so that it can be rolled to advantage.

SIMPLE PHYSICAL TESTS

Testing of the compaction secured on these embankments is based on the weight and volume of samples taken at each dam practically every day that embankment is being placed. Any change in the type of material or any uncertain test result calls for another sample.

Probably the most difficult part of the test is the determination of volume. Two methods are in vogue. In the first a cylinder is used to cut a sample from the embankment. The cylinder has an inside diameter of not quite 6 in. at its cutting end and is about $5^3/_4$ in. long. Above the cutting edge the inside diameter slightly enlarges so that the rebound of a sample does not cause it to bind in the cylinder. A follower of the same diameter is used to force the cylinder into the embankment. The cylinder is pushed in gradually by hand. The material outside is shaved down to about the diameter of the cylinder, an inch or two at a time, as the cylinder is pushed down. When the sample has passed entirely through, the cylinder with its contained sample is removed and the two ends of the cylinder are struck off flush. The cylinder and contents are then weighed on steelyards properly counterweighted for the cylinder. As the sample is 0.1 cu ft in volume, the scales are graduated to read 10 times the actual weight of the sample and thus yield the weight of 1 cu ft of the material directly.

In the second method, sand is dried and then poured gently into a container of known volume to obtain its weight per cubic foot. Then, after the upper uncompacted surface of the embankment is cleaned off, a hole some 8 to 10 in. in diameter and 8 to 10 in. deep is dug into the embankment. This digging has to be very carefully done; disturbed material must be removed and the material in the walls left as it was. All the earth removed is weighed before it has a chance to dry out. The volume of the hole is determined by finding out how much of the sand is required to backfill the hole, the sand being poured in the same careful manner as previously. By weighing the sand left over, the volume of the hole is determined, and from it the unit weight of the material. After the samples are weighed, they are dried out and, by reweighing after drying, the weight of the water is determined.

EMBANKMENTS PROVE DENSE

Generally the material is assumed to have a specific gravity of 2.7. The variation from this figure on samples weighing several pounds has been found to be rarely more than 1 per cent, and that is about as close as the volume can be measured.

From the weight per cubic foot, the water content, and the approximate specific gravity, the air voids are determined with an accuracy probably within 1 or 2 per cent. The air voids in the samples from these embankments appear to be below 5 per cent, and the average is probably around 2 to 3 per cent. This means that there is room for, say, a normal maximum increase of not over 5 per cent of a cubic foot of water, or 3.12 lb for each cubic foot. If the embankment material weighs 130 lb, this means that under the worst conditions the water content can be increased by 2.4 per cent, and in the average embankment, by only about 1.25 per cent. Such slight increase in water content can in no way affect the stability of the embankment. The only way in which the material can take more water is by expansion.

Undisturbed samples from all the embankments are being brought into the laboratory for various tests, including permeability. So far, the laboratory has not been able to get more than a trace of flow through any sample.

Probably one of the best quick tests for an embankment is its behavior under the load of the construction equipment. There should be a visible weave as the equipment passes over it, followed by an immediate rebound. This weave shows that the material has the water content to give it a plastic condition, but not an excess of water. It is possible that a material with no weave may have just the right amount of water, but the chances are that it is underwatered. If there is much weave, there is too much water, and if the surface has a tendency to show a large number of small cracks, the material below has too much water.

Placing Riprap, Tappan Dam
One of the Last Steps in Embankment Construction

Test pits which were put down in several of the embankments showed highly satisfactory material. Also, a number of samples were taken under low spots where water had collected and stood for several days, and other samples were taken where flood water had stood on the slopes of an impervious embankment for nearly a week, to see if there was any tendency for the embankment to absorb additional water. Nothing was found that indicated such absorption.

Judging by all these observations and tests, it is believed that the earth dams for the Muskingum flood control project will amply serve the purpose for which they were designed.

Soil Mechanics Applied to Design of Dams

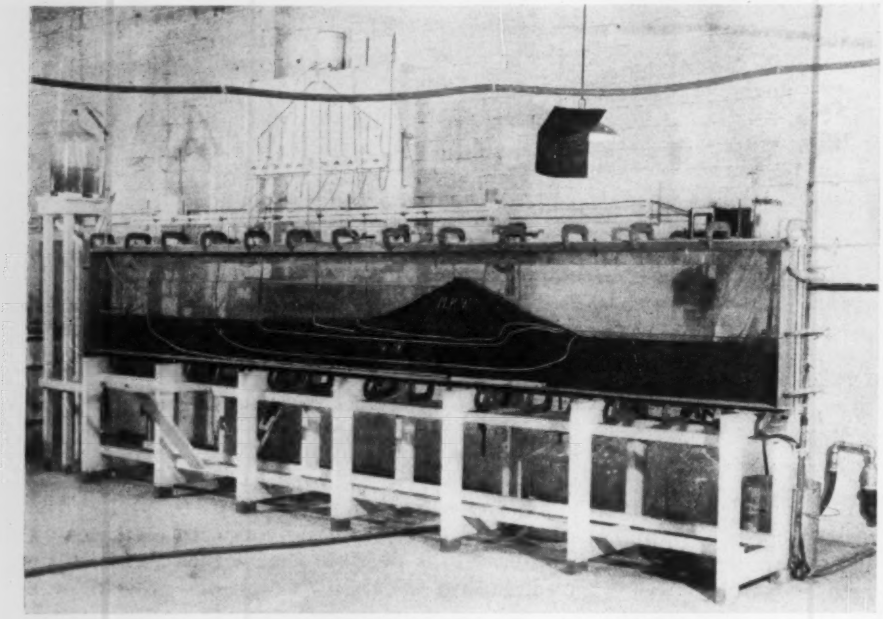
By R. R. Philippe

Associate Engineer and Chief of the Soils Laboratory, U. S. Engineer Office, Zanesville, Ohio

Chief among the materials of construction on the Muskingum project is the soil used in the embankments and found in the foundations. To be consistent in design and construction, the same diligence should be used in dealing with the earthen parts of our structures as is used with the rest.

Unfortunately the study of soil has not kept abreast of the study of other common materials of construction. No industry is profoundly interested in its development and sale; hence the civil engineer has had to study it without the aid of manufacturing interests. Yet the practicing engineer has neither time nor funds to make exhaustive studies along these lines. Thus the profession has found itself most ignorant about its principal material of construction. This state of affairs is aggravated by the complex variety of conditions found in nature.

Thus confounded, the stoic efforts of many an interested engineer have fallen on barren ground. Only in recent years has the profession gone about a systematic study of this problem, aided by schools and governmental agencies and by the organized attempts of the American Society of Civil Engineers, the National Research Council, and other interested bodies. Despite these efforts, new developments have been curtailed, disputed, and discarded, oftentimes by an unfounded prejudice in favor of "accepted" practice. Yet progress has been made, and the significance of that progress is slowly being impressed on the profession.



MODEL OF EARTH DAM UNDERGOING SEEPAGE TESTS
The Permeabilities of Various Parts of the Model Have the Same Relative Values as in the Full-Size Structure

In the Muskingum project, the engineers in charge have made earnest efforts to take advantage of what studies in soil mechanics have been completed and to study in a rational manner the soil problems here involved. With this in mind the soil laboratory at Zanesville was established.

It was realized at the outset that a scientific approach to our problems would involve a tremendous amount of testing, and that a routine must be set up that would take care of the many variations in conditions, and at the same time hold down the volume of testing in order to keep abreast of the demands of contract and design. Only a minimum amount of general research could be carried on. But what are such problems? Specifically, what do they entail?

WHEN IS A DAM WATER-TIGHT?

In the first place, the purpose of a dam is to hold water, and to do so it must be water-tight and it must be stable. Water-tightness needs more definition. One realizes the futility of hoping to attain an impervious structure. Certainly the criteria must differ for the demands of various dams; no demand for tightness in a power dam could be economically applied to a flood control dam. A large seepage in a flood control dam is of no concern, providing the stability of the structure is not endangered. Therefrom evolves the first criterion of dam design—stability from the action of flow.

An examination of the data available on this subject reveals a variation in practice. Justin, for instance, in his book entitled *Earth Dam Projects* refers to a study in which allowable maximum values of the mean velocity of flow were determined. Other investigations, including some made in our own laboratory, show curiously enough that piping occurs when there is a loss of head of approximately one foot in a foot of travel through a soil with an upward flow of water. Hence if we build a dam where the length of path of percolation is no greater than the head, we can be reasonably certain that the dam will fail. As a design criterion, therefore, some factor of safety must be allowed to take care of the irregularities of nature. Our design practice is to use 10, but whether this is adequate in all cases cannot be stated definitely without more investigations.

Avoiding the more or less complicated theory behind such studies, it suffices to point out that the relationship between the head, path of percolation, and variation in permeability of any embankment under study can be expressed as a differential equation. Hence, any method of design must meet the limitations of this equation both in its differential form and in its integrated form—that is, both the dam as a whole and its differential part must conform to analysis. Unfortunately this equation defies solution except for more simple and limited cases. Therefore, to be correct, another method of analysis must be resorted to, namely, the study of models.

THE GENERAL BASIS OF DESIGN OF SOIL MODELS

Let us consider some of the fundamental concepts of such studies. For the present we may begin by assuming the validity of Darcy's law, $Q = KiA$, in which Q represents the flow in time, t; K, the coefficient of permeability; i, the hydraulic gradient; and A, the superficial area of flow. Excluding the coefficient of permeability, all functions are linear, and hence a true scale from model to prototype can be used providing the proper relations of K are maintained.

Now consider two dams of homogeneous section set on an impervious foundation, alike in dimensions and head conditions, except that one is made of sand and the other of clay. Exclude, of course, the possible effects of capillarity. Consider any particle of water on the upstream face, seeking the low potential (or magnet, if you will) at the downstream toe. Must not the path in each case be the same? Would not corresponding alternative paths in the two dams carry the same proportionate increase in resistance?

As the resistance to flow in one case is greater, the resulting total flow would be less, but the flow pattern would be the same regardless of the permeability of the materials. Following the same argument, in going into a more complicated case, to truly simulate conditions it is only necessary to keep all relative paths to the point of low potential in the same proportion. Thus, a model can be built if the permeabilities of the various parts are kept to the same ratios. There will be two scales: that of dimension and that of permeability.

It will be seen that a study of any particular problem requires a measurement of permeability. Many alternative methods are available, but all entail the use of

Darcy's principle applied to a specimen, be it in place as in pumping tests, or in the laboratory, as in permeability tests. At any rate it demands a large number of tests. When one realizes that the variation in permeability is certainly ten-thousand-fold between coarse sand and fine clay, he will see that the possibility of error can only be reduced by a large number of determinations.

Our project has not permitted the time to carry out a great volume of work, so we have been forced to improvise. As the result of several hundred tests on undisturbed samples, a general curve showing permeability with respect to grain size has been developed. Therefore, if the mechanical analysis of a soil is known, its approximate permeability can be fixed. This method cannot be applied to an individual case, but if the mechanical analyses of many samples of a foundation are available, the average permeability of the foundation can be determined. In all cases these results are checked by what tests of undisturbed material are available. The laboratory tests utilize a falling-head permeameter designed to fit an undisturbed sample taken in the field in the form of a 10-in. cube, and similar tests are made on disturbed materials used as parts of the embankment.

From these studies the relative and absolute values of permeabilities in the prototype are fixed, and the basis for the construction of the model is established. The model is built in a glass flume, 14 ft by 2 ft by $^{1}/_{2}$ in., constructed of selected materials, the permeabilities of which are known, and of the same relative value as the corresponding parts of the full-size structure. Head- and tailwater conditions are maintained by the use of overflow siphons. Flow lines are followed by the path traced by dye introduced at points on the upstream face. Flow quantities are measured and can be converted to proportionate flows in the prototype.

HOW MODEL STUDIES AID IN DESIGN

With an estimate of flow quantities the job is partially done, and two possibilities present themselves. First, estimates of velocities can be made and compared to the limiting velocities given by Justin. However, only average conditions can be analyzed by such methods, and the differential solution has not been satisfied. The alternative is to build up a flow net. For those mathematically inclined, a flow net may be defined as the graphical representation of conditions of equi-flow and equi-potential (a solution of the La Place equation). Guided by the flow lines obtained by test, a system of flow and equi-potential lines is built up, which permits the study of the various parts of the embankment under flow conditions. In this manner the differential head loss along any flow tube can be analyzed and the piping criterion applied.

The quantity of flow has little significance except that drainage must be provided for this quantity. Several of the proposed ring levees about towns have been investigated to estimate the pumping equipment.

Other information, however, is obtained from these tests. The boundary of flow can be determined, thus insuring a design that will prevent any seepage from reaching the downstream slope. The relative efficiency of the various parts of embankments can also be tested—for instance, the value of impervious cut-off measures, the effectiveness of blankets, and the proper location of rock toe drains. The Muskingum dams do not have deep cut-offs, for they are built on deep valley fills, and the greater part of the flow takes place at a considerable depth below the original base of the dam. Thus, to be effective, an impervious cut-off measure would have to be quite deep, and therefore expensive. For example, a 40-ft cut-off under Mohawk Dam, at 100 per cent efficiency, would reduce the seepage only some 5 per cent, while an upstream blanket costing approximately the same amount would reduce it 25 per cent. I want to make it clear that this is not an argument against cut-offs in general, but rather an example of what such studies can reveal in particular cases. It should be mentioned that the depth of the valley fill above rock in this case is 120 ft.

A General View of the Soils Laboratory

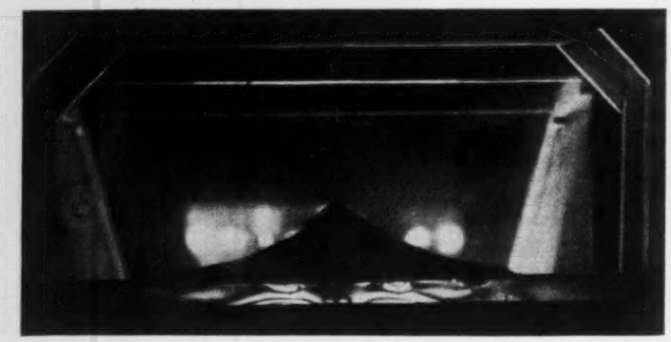
Still another example of the value of these tests was evidenced in connection with the Mohawk Dam. The original design called for a rock toe at the downstream toe of the embankment, which is placed on a terrace that partially blocks the present valley. A model study revealed that the seepage would not seek that rock toe, but rather would go on to the foot of the terrace. Hence, it became necessary to build the rock toe drain at the latter point rather than at the toe of the embankment.

Now let us assume that all the precautions against failure from seepage, as here described, have been taken. There is yet no assurance that the structure is stable. It is still possible that the embankment, by its weight, can cause failure either within itself or in the foundation. For the purpose of discussion, let us suppose that the embankments are so constructed that they, within themselves, are stable, and proceed to the analysis of foundation conditions.

INVESTIGATIONS OF STABILITY MUST TAKE INTO ACCOUNT THE STRESSES IN THE FOUNDATION MATERIAL

Let us review the ordinary concepts of structural design. First, from an analysis of the loads applied and the dimensions of the structure considered, the stresses induced can be computed. If these stresses exceed the limitation of strength offered by the physical characteristics of the structure, either the loads or dimensions must change, or the physical strength of the member must be increased. The foundation of any structure should be analyzed in a similar manner, for the foundation of a structure is certainly part of the stress medium of that structure. Any rational method of analysis must propose an analysis of stress in the foundation, and the resulting stress should be examined to see that it does not exceed the measured strength of that foundation material.

Unfortunately, the plan has its difficulties, but in principle it amounts to a dual analysis for comparison—namely, an analysis of the stresses induced and a measure of the strength of the materials, the soil.



SHEAR STRESSES AS SHOWN BY THE PHOTO-ELASTIC METHOD

The analysis of stress carries with it certain assumptions, of which the principal one is elasticity. With such an assumption, the analysis falls back on the work of such investigators as Brussinesq, Carothers, Terzaghi, and Love. An effective treatment of this work is found in a paper by Dr. Jurgenson in the July 1934 *Journal of the Boston Society of Civil Engineers*. Dr. Jurgenson introduces some original work based on the works of Henchy and Prandtl, German investigators. In addition, the laboratory at Zanesville has developed a photo-elastic method of investigation as a demonstration of the principles involved, to check the theories advanced, and to simplify the method of analysis.

It is recognized that failures in foundations are due to overstress in shear. The principal stresses induced will cause certain volume changes, covered in general by the theory of consolidation. The shearing stresses, however, have to be borne by the immediate shearing strengths of the material if the structure is to be stable. The magnitude of these stresses depends upon the non-uniformity of loading. Hence, an embankment with steep slopes will induce higher shearing stress than one with flat slopes. In addition, the magnitude of the stresses induced is a direct function of the depth of questionable foundation material. This fact is of utmost importance. It suffices to say that, within certain limits, as the depth increases, the stress increases.

To complete the analysis, the shearing strength of the foundation material must be measured—that is, the working strength of the soils considered must be established just as the working strength of steel has been established by repeated tests. The difference between soil and steel is that soil demands individual treatment, while steel conforms to an average strength sufficiently well for that average to be used at all times.

HOW SHEARING STRENGTH IS DETERMINED

There are various methods of determining shearing strength. Professor Housel, of the University of Michigan, is an advocate of loading tests. This method is useful but extremely difficult to interpret correctly in a non-homogeneous case. The method evolved by Drs. Terzaghi, Gilboy, Leo and Arthur Casagrande, Jurgenson, and others, conforms more or less to the more ordinary methods of test analyses. Basically, it involves the testing of individual specimens of the foundation in an undisturbed state. Great care is taken in obtaining samples of the foundation so that they remain undisturbed in water content and structure. Samples so taken are carefully carved to fit testing equipment, which can shear a specimen under any given vertical load. By test, then, the strength in shear of the foundation specimen with respect to the vertical load applied is established. It then remains to fix the vertical load effective on the sample, to establish the strength of the foundation material in place. At the outset, the present overburden pressure is effective and is used as an initial condition. However, as the construction of the embankment proceeds, a certain amount of consolidation will take place.

The time effects, as a result, become extremely important and, in general, a computable quantity. Briefly, the principal stresses applied are initially taken up by the water in the soil and the shear by the soil itself. With time, the water is driven out and the principal stresses are transferred to the soil. The result of this addition of pressure is an increase in the shearing strength of the soil. Thus, by properly planning the rate of construction, savings can be made with no loss of safety. The effective design, however, is based on the comparison of stress and strength at any given moment. Our practice has been to use a factor of safety of at least 1.5 against overstress. It should be remembered that overstress does not mean failure until it overbalances the understress in other parts of the foundation.

Although the stability of the foundation is thus assured, movements in the foundation will still take place as a result of the application of principal stresses. In the construction of embankments of great base width, such as ours, the vertical distortion due to the horizontal stress can be neglected when stability is assured, and the only pressures considered are those exerted by the applied loads in the vertical sense. The analysis falls under the limitations of the theory of consolidation; hence tests on the same undisturbed sample will reveal the properties of strain under vertical load, which, if applied to the foundation as a whole, will allow an estimate of the settlement that will occur. Time observations on these tests can be applied to the prototype and the time rate of settlement established. The value of these tests is threefold: First, an estimate of the total settlement is made and that allowance added to the height of the embankment to preserve freeboard; second, the load effective at any given time can be computed to estimate the addition of shearing strength due to applied loads; third, the time rate of settlement in an embankment can be predetermined and watched during construction—any large deviation from this rate of settlement is a warning of trouble.

THE LABORATORY ROUTINE

So far, nothing has been said of the routine set up in the laboratory as a preliminary aid in establishing the problem. Our policy has been to obtain uniform classification of all soils by means of suitable tests of grain size and water content. Then, with the visual classification of a trained observer, the occasional check by grain size curves, and the information obtained from individual water content tests, the extent and nature of the problems encountered at any site can be determined. With this as a basis, we can proceed to a solution by the methods that have been outlined herein.

Some Problems of Suretyship

Reinsurance, Underwriting Rates, Defaults, Recoveries, and Similar Elements

By HERBERT M. KNIGHT

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER, MARYLAND CASUALTY COMPANY, NEW YORK, N.Y.

IN his previous papers in the October and November 1935 issues, Mr. Knight has defined the nature of suretyship and has traced the preliminary steps that must be taken before the surety company is satisfied to accept the risk offered by the contractor. The developments are even then far from complete, as the present paper graphically illustrates. It may be necessary to spread the hazard over a number of companies and some may decline, to the embarrassment of all concerned. Rates are barely sufficient to cover all the needs; at best the return to the surety is very moderate. And if worst comes to worst a default is entered. The surety must then arrange to complete the contract as best it may and satisfy all claims. Not the least of the value of this third paper is contributed by the many apt illustrations taken from Mr. Knight's own wide experience and lending reality as well as reasonableness to his contentions. This paper, like its predecessors, is an independent part of an address which was given before the Brown Engineering Association at its meeting on October 30, 1934, in New York, N.Y.

SOME of the basic factors connected with surety bonds, details of the many preliminary steps in obtaining a bond, and the parties affected have been described in previous papers. This article deals with the working of the agreement between the owner, the contractor, and the surety through all the difficulties that may arise during the life of the document.

It is assumed then that the offering by the contractor has passed the acid test of the underwriter; it has been approved. If the bond is a small one, the matter is disposed of for good; if large, it is often only begun. No single company wants to carry the entire hazard of a bond of considerable size, even if it could. Beyond the risk of the company originating the bond there is an obstacle known as "qualifying power." This is a limitation set up by national, state, and municipal governments, establishing the maximum amounts for which a bonding company can assume liability under a single bond. The amount varies—with the U. S. Government it is 10 per cent of the total of capital and surplus; elsewhere it may be arbitrary and, as in the case of New York City, may be limited to a definite sum. Therefore if the bond is in excess of the legal or desired limits of the bonding company, it must be divided with other surety companies. Most such companies have an agency known as "the Treaty," composed of a few associated companies, to which a certain percentage of all bonds above an established minimum are automatically ceded. But with bonds of greater size, other expedients are required in order to secure a proper "spread" of the exposure. There are two such expedients—co-suretyship and reinsurance.

WHAT IS CO-SURETYSHIP?

Co-surety is that form of subdivision by which several surety companies combine to bear the risk, each assuming a definite part of the obligation, which definite amount is set forth in the instrument of surety. In the event of default or demand, each of these surety companies is directly responsible. Such co-suretyship is common on very large bonds. A recent bond for a government contract carried 22 co-sureties. Only one step is necessary to make co-suretyship the most satisfactory and equitable form of guarantee, this step being the acceptance by engineers and administrators of that form of co-surety bond known as "limited proportionate coverage." As at present written, the co-surety bond, while limiting the obligation to a definite sum, does not provide, in case of default, that each surety shall be responsible for only such proportion of the loss as its obligation bears to the penal sum of the bond, so that, in the event of a liquidation or other suspension of one or more of the co-sureties, the remaining companies would be called upon to meet more than their proportionate share, up to the amount of their obligation. It seems only fair and equitable that this liability should be reduced to the proportionate amount. Even under co-suretyship, the co-sureties may cede, or reinsure, some part of their exposure to other companies not participating in the bond. There are certain companies that are organized for reinsuring purposes only and never originate business on their own behalf or initiative. Such companies usually operate upon a very safe and sound basis, and because of the non-originating feature have a comparatively small overhead.

When co-suretyship is impossible or unnecessary, a form of distribution known as "reinsurance" is adopted. The originating company receives acceptances, from other companies to which it has submitted the underwriting memoranda, of some percentage of the total penalty, and an agreement is entered into between the originating company and these other companies by which they bind themselves mutually with respect to this obligation and any demands which may originate under it. This agreement is between the companies and is not a part of the bond, the originating company being the only party mentioned in that instrument as guarantor. In the event of default or demand, the originating company is the one upon which demand or notice is made, the originating company conferring with its reinsurers regarding the conduct of the case arising from such default or demand.

From these facts it will be perceived how careful and complete, as well as accurate, must be the work of the underwriter in preparing his case for submission to the underwriters or underwriting committees of other surety companies for their acceptance of participation in the bond. Then, too, it will be immediately apparent how dangerous and damaging a "declination" may become. One declination is often a serious handicap to the ultimate execution of the bond, and if several companies have unsuccessfully attempted to launch a bond, or if several companies have definitely refused to participate, the task is tremendous. When it is considered that the government qualifying list names only 70 companies and that only 10 of these have qualifying powers in excess of $500,000, the limitation of the field is immediately apparent, and the necessity of forestalling and preventing declination is imperative. "The Street," that limited half-acre centering at John and William streets in New York City, and really the pulse of the entire bonding business of the country, is a very sensitive spot—very susceptible to rumor and to doubt.

HOW RATES ARE ESTABLISHED

If all the hurdles and hazards enumerated have been successfully negotiated, it might be held that this is the conclusion of the whole matter. Those who have to do with bond underwriting often wish it were. But unfortunately the "best laid plans o' mice and men gang oft agley." With all the care in the world, some problems will not solve themselves in just the way it has been planned that they should, and this is true with reference to bonds as it is with life. Sometimes defaults will occur; and sometimes contractors fail to pay their premiums. This naturally leads us to the subject of rates. Some consideration of this subject—how rates are established and what is done with them—may be of interest to engineers.

Grand Coulee Dam, September 1935, Looking West (River Flows North)
Twenty-Two Co-Sureties Combined in the Bond for Completion of This $29,000,000 Contract. This Is One of the Three Largest Surety Bonds Ever Negotiated

A few decades ago there was keen, and often killing, competition between competing surety companies, both in the securing of business and in the establishment of rates at which that business should be written. Chaos worse confounded existed in the field of construction bond writing, and no one could tell from day to day, either as bondsman or contractor, what would be the rate applicable to any bond. As a consequence, and in order to end, once and forever, such an undesirable condition of affairs, the bonding executives got together and formed an organization known as the "Surety Association." This association adopted certain rules of "fair practice" which, as modified from time to time to meet growth and unforeseen conditions, have since operated to stabilize and coordinate the entire bond-writing field. At the same time an agency was created known as the "Towner Rating Bureau," which, under the able and intelligent administration of R. H. Towner and his associates, determines and establishes rates for all the myriad and multiform coverages required in the conduct of modern business engagements. Most of the surety companies writing contract and other bonds are members of the Association and are bound to comply with the rules and rates promulgated and established by the Association and its agents. A very few companies, known in the "Street" as "cut-rate," are not members of the Association and are therefore not bound by the rules and rates of the Association members; that is, they are not "treaty" companies, as Association members are designated. The Towner Rating Bureau issues a publication called "The Manual," which is a rate book, the handbook of suretyship—its *vade mecum*. This manual is being constantly added to and revised as new forms of coverage are instituted or required in order to meet the expansion of modern business, or more fully and equitably to fit rates to experience.

However, whether rates are "manual" or "cut," it is required that they be filed with the superintendent (or commissioner) of insurance of each of the several states in which the surety companies are empowered to transact business. Once so filed, such rate becomes mandatory upon the surety representative executing a bond within that state, departure from which rate may under some circumstances be held a penal offense. There is a strict compliance with published rates.

The association not only requires compliance with the published premium rates, it also demands compliance with the commission rates paid to agents and brokers from which the business is received. Under the "acquisition cost" rules of the Association, certain agencies, ways, or channels through which to secure business are established—known as general agents, special agents, city agents, and brokers, to whom certain fixed rates of commissions are payable and no more, such rates ranging from a maximum of 30 per cent to a smaller ratio.

DETERMINING PREMIUMS

Under the laws of the various states, the surety company, immediately upon the execution of a bond, must set up a "premium reserve" as a protection or guarantee fund, to meet losses growing out of the business. Insurance laws are involved and complicated instruments, and although I have read them and pondered over their reserve requirements, I dare not definitely state exactly what are the premium reserve requirements of such laws, but I think it may be sufficiently close to truth to say that they vary from 50 per cent on short-term instruments to 70 per cent on long-term, such reserves being represented by investment in approved securities.

Such are the limitations which surround the business, after the bond has been executed. There are fixed rates, determined commissions and costs, and segregation of funds. To these must be added constant supervision and inspection by state and other auditors to secure compliance with the established laws and rules, to check up on false rates, and to get assurance of continued financial strength and liquidity.

HOW PROFITABLE IS SURETYSHIP?

Through the years it has been found that for most companies, losses, including the costs of adjudicating and settling claims, rarely fall below 54 per cent and are quite likely to run larger. If they do not run above 58 per cent the business of suretyship may continue, though not very profitably. It may be generally asserted that, with a loss ratio of 56 per cent, a maximum protection cost of 30 per cent, and a home office cost of 12 per cent—that is, 98 per cent of the premium dollar—any company can continue in business. It is the possibility of loss ratios mounting above 56 per cent and for more than one year in succession, that makes such large ratios staggering and portentious. The business of suretyship, from the executive angle, is to a very considerable degree that of an investment trust, that is, the business of so investing and handling its reserve funds that they may be a sure and certain reservoir for dividends and surplus.

I have previously referred to the reserves required to be set up as a protection to the public. These reserves, both legal and voluntary in excess of legal requirements, together with the large volume of investment transactions carried on throughout a business year, are tremendous, and the income on such reserves and investments, together with their appreciation in value, in normal years represents a respectable sum, one from which the company can safely and honestly pay dividends or add to surplus. But when loss and expense ratios rise higher, or when successive lean years come, the small premium margin has not been found sufficient to meet all the demands. Upon analysis it must seem rather pitiful for a company to write, say, $30,000,000 of business in a year and consider itself fortunate if at the end it can show a margin of profit of from 1 to 2 per cent. Where is the contractor who would be satisfied with such a meager net return on such hazardous and involved transactions? Conversely, one salient fact in the discussion of sureties and rates frequently lost sight of by the engineer and contracting world should be emphasized. This is that out of every 100 cents that sureties receive, from 96 to 98 cents are returned again to the public in wages, commissions, and losses paid. Suretyship may well be held to be essentially benevolent in its activities.

SPEAKING OF DEFAULTS AND CLAIMS

One might well hesitate before entering upon the vast and unexplored field of defaults and claims. My only excuse must be that with all its variations and discordant aspects, it is a matter in which engineers quite often become involved, and one in which they could very well be better versed as a profession. Engineering in many of its functions is judicial, and in these functions should be just, not only to employers, but to contractors and sureties as well.

To illustrate, a large lump-sum contract was being performed for an important railroad. Included in this contract were many important and scattered structures. While the contractor was employed upon certain of these structures, the railroad modified a large structure already completed and requested the contractor to dismantle equipment and replace at the modified structure. When the contractor demurred against compliance without compensation for dismantling, transfer, and restoration, the engineer readily consented to such compensation. The contractor immediately transferred his equipment as requested. He filed his account and months went by without payment. Finally, tired of the long delay and the unsatisfactory excuses of the engineer, a forceful request by the contractor elicited the following statement by the engineer. "I work for the —— railroad. It is my business to get everything I can for it, and for as little as possible. I knew you would not move your equipment immediately unless I agreed to pay you, which I did. But I never intended to pay you; your bill will not be paid without my approval, and—I will never approve."

A large school was under construction. When the bottom of the footings was reached it was found that the material encountered was wholly unfitted to support the structure. By written order of the architect, excavation was continued until a satisfactory supporting stratum was encountered. The contractor proceeded with construction, and without payment for the large amount of extra work involved, until he found himself without the necessary funds with which to complete, owing to the heavy expense of this excavation. His demand for payment was refused by the board, despite the architect's order, on the ground that the defective supporting material should have been discovered by the contractor in advance, and for the further, and to them more important reason, that payment for this extra excavation would be in excess of the appropriation, which they (the board) were by law prohibited from exceeding. They demanded that the surety complete.

ENGINEERS CAN HELP TO PREVENT DEFAULT

In another instance, a bridge was intended to carry a wide thoroughfare across a large river. The contractors began work by driving steel sheet piling and found that instead of earth in the river bed, as shown on the plans, there was only rock. It was found impossible because of the irregularity of this rocky bed to completely seal the cofferdam. In addition, a large water main, not shown on the plans, came within the cofferdam. The contractor asked for two things, that he be allowed to deposit concrete in water, under satisfactory conditions, and that the owner either care for the water main or issue orders to him so to do. Both requests were refused. The contractor defaulted. Another contractor completed the contract after both requests had been granted to him and completed it at the expense of the surety.

Of course it is admitted that engineers are often not free agents in the complicated legal tangles that surround defaulted contracts, but often defaults can be traced directly to the inequitable attitude of the engineer. And it is because debatable and inequitable incidents often occur during the progress of the work that the claim departments of surety companies are so keen and so quick to deny liability and to seek the arbitrament of courts as to their legal responsibility. No surety company of standing, within my knowledge, repudiates its obligations, where there has been a reasonable compliance with the terms of contract, plans, specifications, and its bond, which is never held to be "a scrap of paper."

COMPLETION OF DEFAULTED CONTRACTS

Surety companies rarely complete a defaulted contract. Nearly always their experience in so doing has been a bitter one. As soon as word goes out that "the surety company is finishing the job," just so soon do all costs mount. There are, it is true, some outstanding examples to the contrary, but these rare exceptions only prove the rule—that it is safer and cheaper to let some one else finish.

Yet surety companies rarely leave the matter of completion to chance. The usual method of procedure is if possible to continue the operation with the contractor's forces until a number of bids from other reputable and selected contractors can be secured, one of which will be preferential—known as a protection bid. The surety then selects the one it desires to finish the work and offers this contractor to the owner (the obligee). The new contractor will either complete the work directly for the obligee, giving a new bond of another surety company, the original bonding company (the guarantor) agreeing to pay any difference in cost to the obligee;

or the new contractor will enter into a contract with the original surety, furnishing it with the guarantee of another surety company, payments under the contract being made to the original surety or to the new contractor, direct, as may be decided by the parties principal, that is, the original surety, the new contractor, and the owner or obligee. The completing surety company then agrees to compensate the new contractor direct for any excess which his contract may cost over the original one.

While this method of procedure, for all practical purposes, may be "completion by the surety," it is distinctly different from direct completion, in which the surety meets all payroll and other costs as they are incurred. The "loss" of the surety in the one method is determined and established, in the other it is liable to be almost anything. Surety companies prefer to know what their losses are, large though they may be, rather than to be subject to the nightmare of mounting costs with no positive limit.

One matter, vitally related to the questions of the premium charged and to recovery, is the size or penal sum of the bond as related to the total of the contract. It is an axiom of suretyship that "The contract is the measure of hazard; the penalty, the measure of liability." Now at first thought it may not seem clear that it is proper in a case where a penalty may be, say, 50 per cent of the total of a contract, to charge the same amount as where the penalty is 100 per cent; but the surety is carrying the hazard of default always on the gross amount of the contract, and in the event of a default at any time its liability may be the penal sum. In the case cited, where there is a bond penalty of 50 per cent of the contract amount, if the charge were based on the penalty, the surety would carry half of the hazard for nothing. Again, whatever the amount of the penalty, the obligee, in the event of default, is only entitled to recover his actual, provable damage; and a bond penalty in excess of the contract amount cannot be enforced if the actual damage cannot be proved. Double and triple penalty bonds are not only suspicious documents, making writing much harder; they are more difficult to enforce.

REGARDING LIENS AND RECOVERIES

The laws of the various states are so often divergent in phrase and interpretation that it is impossible to say, for the nation as a whole, just what is and what is not lienable as against a surety company. Furthermore, bonds are so diverse in their phraseology and in their coverage that no fixed rule of procedure can be stated. Nevertheless, experience indicates certain probabilities. In the first place a bond guaranteeing against liens does not insure that the surety will, or will immediately, pay any and all liens which may be filed against an enterprise. It simply provides that the surety will protect the obligee against all liens which may be enforceable. The surety may file its release of lien bond to make possible restoration of payments under a contract, but payment of such liens is only made after proof, compromise, or arbitrament of courts, and rightly so.

Not only are fictitious claims often presented—claims based upon anticipation rather than performance—but in multitudes of ways claimants hope to recover in excess of either legal or reasonable limits, in many cases as the result of credits extended to contractors to whom they would not have sold anything except for the prospect of recovery from the surety. Surety claim executives do not fight honest claimants or force them into litigation. They may, and often do, seek compromise, which seems only fair and right in view of the fact that the claimant and the surety have made a mutual error in extending credit. But if there is any arbitrary, questionable, or defective condition or attitude incident to the claim or the adjudication thereof, the claimant must prove his right to recovery.

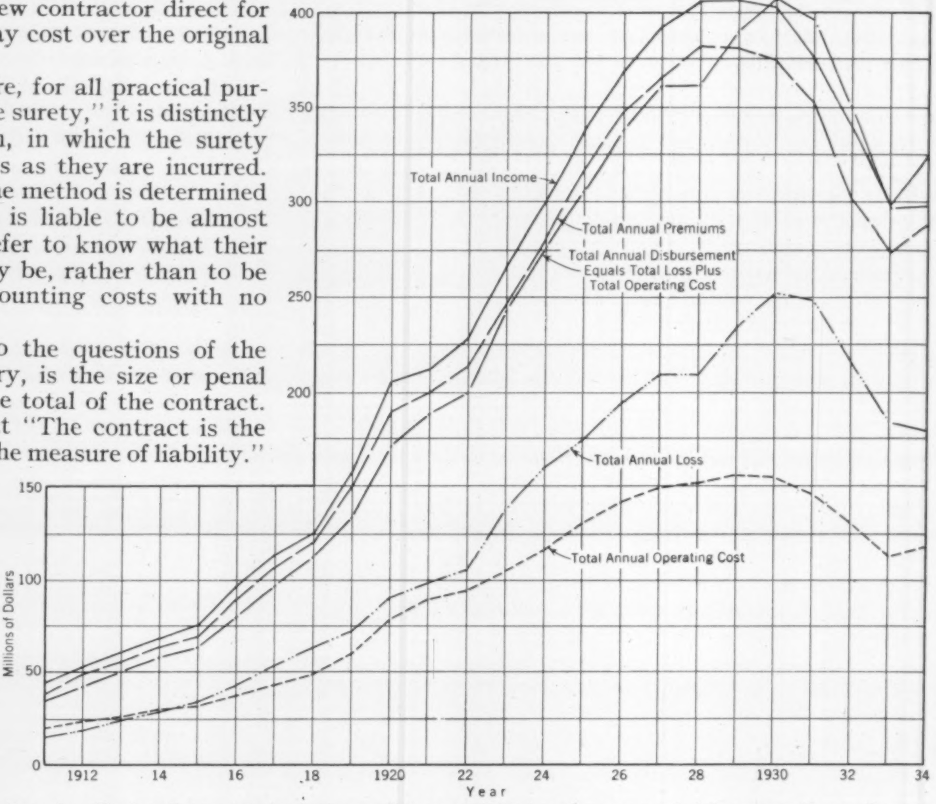


FIG. 1. CHART SHOWING AGGREGATE FINANCIAL EXPERIENCE OF 31 MULTIPLE-LINE SURETY COMPANIES FROM 1911 TO 1934

It may be set forth as an axiom that whatever has been actually incorporated in the work is lienable and, if proved, always subject to recovery. Labor and material come definitely under this category. But there are a great variety of other things not positively recoverable which may enter into the construction and yet not be incorporated therein, and it is in relation to these "other things" that a great mass of litigation and diverse legal judgments has accumulated. Such things may include tools, supplies, equipment, rentals, repairs, and services other than labor. If a contractor buys tools, including for instance automobile tires which may be usable on other work or in other ways, and does not pay for them, why should the surety be liable for the purchase? Or if he buys tires for his trucks and for his private cars not used on the work, why should the dealer hope to recover for all tires? If the contractor equips his work, and does not completely pay for such equipment, which may have a real value in excess of a sale value, why should the surety be called upon to pay for the greater deficiency? If repairs are made to trucks or other equipment, who can say just what made the repairs necessary, whether this job or some other; or whether the entire value of such repairs inured to this particular work or to some subsequent work? Rentals of equipment or of property, water, oil, gasoline, fuel, power, light, and telephone service are always debatable subjects under claims. The great questions relating to the "lien law" and to whether material has been "consumed or not consumed" are the fulcrums around which the arguments turn.

Ordinarily the obligee has prior right of recovery under the bond, and claimants may, and often do, have to wait until the rights of the obligee have been terminated or determined. Some bonds, as certain state bonds, bind the surety only to the state for the performance of the contract and for the payment of any damages or judgments which the state may be called upon to pay. Other bonds, such as certain government and labor and material bonds, give all claimants "direct right of action" against the surety, some after the expiration of a certain period of time after completion. This "direct-right-of-action" feature, which is recent, may be a totally unwarranted hardship for any surety company. Under the clause as usually incorporated, action can be brought by any one, anywhere, for any alleged claim on account of any work or service. That is, work performed in California on some feature connected with construction in Maine, may be sued for against the surety in California, necessitating heavy legal expense and costly transportation of witnesses across the country and back in order to combat an excessive or perhaps a fraudulent claim. These hardships are now legally enforceable. Under this "direct-right-of-action" provision, which permits and favors claims beyond those arising directly from construction, it was held by the court, in one instance, that a bill for hay supplied by a dealer and fed to mules owned by a teamster employed in carting for a subcontractor, working under a general contractor, was recoverable from the surety.

To still further burden the surety, the "Miller Bill" was recently enacted by Congress, requiring two bonds, one known as a "Performance Bond" for the protection of the United States, and another known as a "Payment Bond" for the protection of all persons supplying labor and material, this bond to be for one-half of the amount of the contract. That is, the surety must assume a burden equal to $1^1/_2$ times the contract amount, with no increase to it in premiums. Again this recent law permits a subcontractor to begin suit, within 90 days after performing work or furnishing labor, in the name of the United States in a U. S. District Court.

Actually this act is fraught with untold hazards both legal and financial to surety companies, as it will multiply litigation and add materially to the costs arising in dangerous or sick contracts. Again the act fails to state what are "materials," a fact previously referred to as a prolific source of controversy. Contractors will probably discover that the "90-day suit" provision will lend itself to extortion or deliberate efforts to embarrass or destroy a contractor financially. And to show graphically the history of the business of suretyship over more than 20 years, Fig. 1 is presented. A study of the experience of those 31 large companies, especially since 1928, should give pause to those who recognize the use and value of suretyship as the stabilizer of modern business, as to what its future will be when considered in the light of increased relative disbursements in conjunction with decreased premium returns.

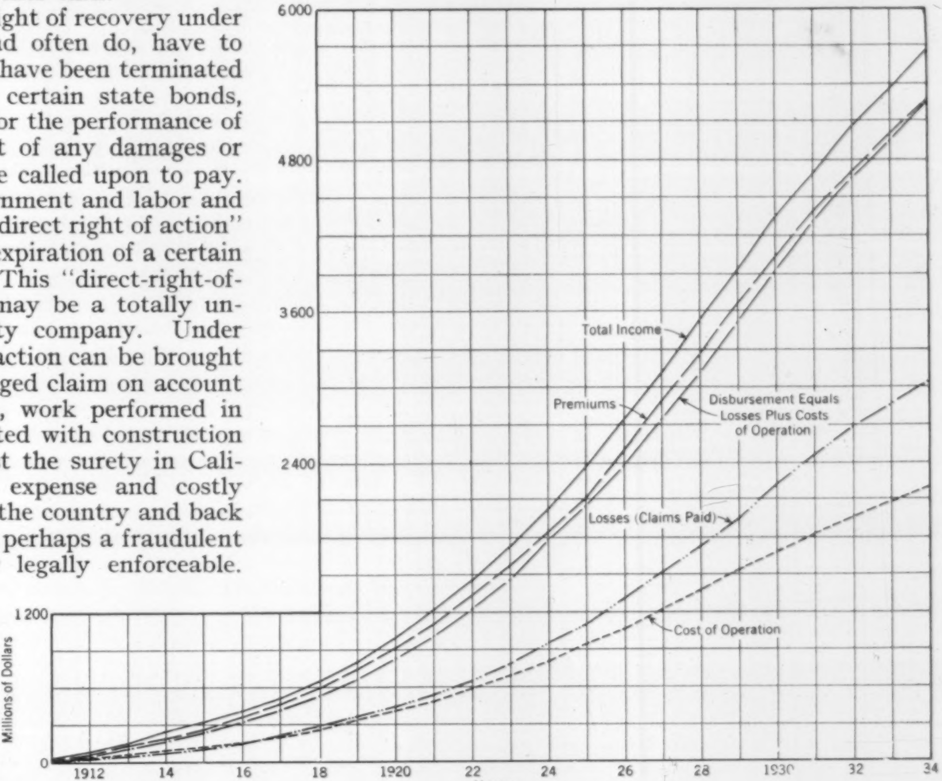


Fig. 2. Accumulative Values of Finances of 31 Multiple-Line Surety Companies, Beginning in 1911

Finally let me urge upon engineers and their allies, the contractors, a juster and more appreciative recognition of the function, as well as the performance, of the sureties. The three are mutually dependent. Neither can exist and prosper to the greatest degree without the other. Each works for a monetary return. Idealistic as engineering may fundamentally be, it is nevertheless a source of revenue to those engaged in it, or else they cease to function as engineers. Contracting is an inspiring, an absorbing calling, and great contractors are among a nation's richest assets, but no contractor can live long as such whose return is less than his outgo. So with suretyship and those who find in it their interest and their means of livelihood. It must have an opportunity to show a reasonable net return on its thought and effort or it will cease to be an aid to business and to construction. Its rates and its coverages must be no greater than the exigencies of the enterprise call for, and those who add to its burdens, without adding to its ability to meet those burdens, are injuring general business as a whole, as much, if not more, than they are injuring suretyship; for in the final analysis the return must fit the penalty.

Largely I look at this problem from one angle. What does it cost the public—that vast aggregation, of which we each and all are so small a part, and which we in blanket phrase term the "ultimate consumer?" For no matter whose name may be on our pay check, the body politic is the one for whom we really work and who pays the bills. Can suretyship show that it has kept the cost of living down; can it show that it has promoted and safeguarded enterprise and endeavor for the common good; and that in so doing it is asking no more than a just and commensurate return for what it has to offer? I believe sincerely that it can.

Helping to Span the Pacific

Voyage of the "China Clipper" Made Possible by Base Built at Midway Island

By ALBERT A. MITTAG
ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER IN CHARGE OF CONSTRUCTION, PAN-AMERICAN AIRWAYS, INC., ISLAND OF MIDWAY, PACIFIC OCEAN

SUCCESSFULLY completing the first commercial round trip by air across the North Pacific on December 6 without a hitch, the "China Clipper" of the Pan-American Airways set an enviable record. The brilliant accomplishment of men and machines has been widely acclaimed, but this article indicates another element contributing to such an epochal success—the thorough preparation for the flight, as illustrated by the landing station developed at Midway Island. Material for this extensive plant half-way round the world was carefully assembled and loaded into a chartered vessel at San Francisco in reverse order of use. Fourteen buildings in all, including a power plant, living quarters, service buildings, and docking facilities, were included. Interesting details of construction and living conditions from the standpoint of the construction engineer are included in Mr. Mittag's article. It is worthy of note that the careful planning of this work jointly with that at Wake Island, the next station beyond, brought about its completion, and the return of the expedition, within one day of the four months originally projected.

FROM the time when wings first soared across the Pacific the idea of a commercial airway between the Far East with the United States has been a possibility envisioned by dreamers, scoffed at by the man in the street, but now brought to fruition by the Pan-American Airways on the completion of the last leg of the flight from West to East by the Pan-American "China Clipper."

Leaving San Francisco on November 22, 1935, the Clipper thrilled the world as it spanned the broad Pacific in five hops (Fig. 1) totaling 7,000 miles, accomplishing this trip "without incident," according to the report of its master.

When regular service is established, the total distance of 7,600 nautical miles to Hong Kong, where connection will be made with the Pan-American system in the Orient, will be covered in four days. Imagine what Magellan would have thought of this! Even the modern steamship, swift greyhound of the seas, bows to Father Time and takes 16 days to accomplish the trip.

In part this remarkable achievement depended on the satisfactory preparation of intermediate bases, such as that at the end of the second flight, on Midway Island, described here. Office work was begun in New York the latter part of January 1935. With general plans and material specifications drawn up, the bill of materials had to be painstakingly accurate since an item once left behind had to be done without, for the proposed site was on a small island out in the broad Pacific far from the path of all ordinary steamship traffic lanes. The isolation of the Wake Islands would be complete from the time the supply ship dropped the construction crews and materials until its return three months later, when the project was to be turned over to the operating personnel of the Pan-American Airways.

Time being an essential factor, considerable thought had to be given as to the method of loading and unloading the supply ship. Materials for foundations had to come out first and the remainder in proper order. To facilitate the loading, a dock was rented on the San Francisco waterfront, and there the material was segregated, first as to the order of construction of the buildings and then as to the order in which the material went into these buildings. Non-essentials, that is, those goods not needed in actual construction, like furniture, went into the bottom of the ship, and the rest followed in the reverse order of actual use. The success of the loading and unloading was in evidence at Midway, when posts followed sills, girders, posts, and so on throughout the entire cargo.

Honolulu, Sumay (on Guam), and Manila, being on large, well-populated islands, presented no problems other than the securing of essential building materials and the construction of the radio direction finders. Advantage was taken of existing facilities at these stations and little actual construction was done. Midway and Wake Islands, however, called for the construction of complete airports—from quarters to house the personnel, shops, a power house to generate electricity, refrigeration units to preserve food for 36 men for a period of four months, and windmills for the pumping of water, to radio plants to contact the outside world. The whole project demanded careful planning and preparation.

Midway Island is a circular atoll about six miles in diameter inclosing two islands. As the name suggests, it is practically half-way round the world from the zero of longitude, being 177°22′46″ west of Greenwich and in latitude 28°12′52″ north. It is composed of Midway, with an area of 1.44 sq miles, and Eastern Island, with an area of approximately 1.0 sq mile. A coral reef 5 to 10 ft wide and projecting above the water from 1 to 5 ft surrounds the island, except for two passageways,

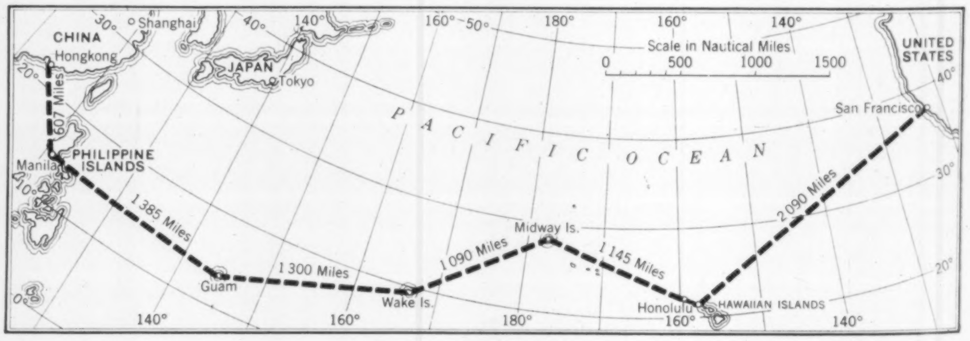


FIG. 1. ROUTE OF PAN-AMERICAN AIRWAYS, SAN FRANCISCO TO HONG KONG
Distances in Nautical Miles

one on the northwest and one on the southeast. Within the confines of the two islands is a lagoon of variable depth. Its coloring is from a light green to a deep blue, and under the semi-tropical sun it presents a beautiful picture, not easily forgotten. It was on the eastern shore of Midway that the Pan-American Airways found the most desirable location for their purposes. Here was a snug harbor that offered protection from the elements during the winter months and at the same time gave them sufficient depth of water to operate their largest planes.

In San Francisco Bay

Loading the "Midway" on Board the Modern Argosy, the "North Haven"

Previously, in 1903, a cable station had been established there. The cable company found the island a sand dune without a blade of grass. After thirty years of occupancy they have made their compound a virtual paradise, having imported top soil, plants, and bird life. The remainder of the island is covered with a growth locally called magnolia. I have never seen anything like it and can only compare it with the mangrove found in Central and South America. It has a leaf that looks like the magnolia of our southern states, from which it probably derived its name.

Diesel Generator Set on Ice Blocks

Adjusting Settlement with a Blow Torch

Midway enjoys a climate similar to that of Florida. Its so-called dry season extends from January to August, and the wet season from August to December. The rainfall averages about 24 in. per year. Wind intensities up to 75 miles per hr have been recorded. Rains, generally accompanied by heavy winds, are very uncomfortable. Two weeks after our party landed a rainfall of 2.02 in. was recorded in 19 hr, with a total of 4 in. in the first four weeks.

The program called for the construction of 14 buildings and utilities (Fig. 2), as well as two windmills with 8,000-gal storage tanks; four 4,000-gal and one 2,000-gal fresh-water cisterns; one 2,000-gal diesel fuel storage tank; one 4,000-gal gasoline storage tank; six septic tanks and filter beds; 276 ft of pier; 24 ft of pontoons; gasoline dumps; radio receiver poles; radio transmitter poles; and the highly complicated radio direction finder of 16 poles, with all its appurtenances. Besides this there had to be installed 1,200 ft of 3-in. gasoline line, 8,000 ft of 2-in. water lines, and over 13,000 ft of power cable, including street lighting from the airport office to the dock.

The buildings, of a semi-knock-down type, consist of 4 by 10-ft panels of three-ply plywood, in two layers separated by $1^{5}/_{8}$-in. studs. Panels are put together by means of splines that fit in between the layers of plywood and are tacked to it.

Roofing material, of No. 12 canvas, was put down by, first, applying a coat of paint to the wood roof panel; second, laying the canvas, bone dry, and tacking it down; next, applying water to the canvas; and, finally, as soon as it had dried sufficiently to be just slightly damp and the canvas taut, applying a primer coat of canvas paint. Several weeks after the primer coat a second coat was put on.

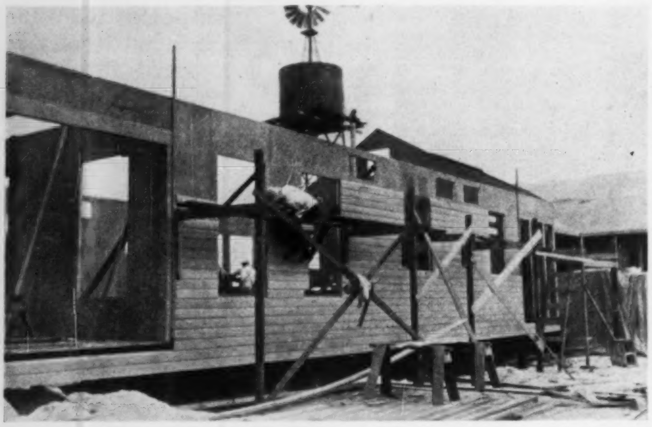
Water is found everywhere on the Island from one to three feet below the surface. It is brackish and contains considerable sulfur. Although slightly unpleasant to the taste it is potable, and was used by a considerable number of the construction crew throughout their stay on the island. One well, 6 by 6 ft in plan and 8 ft deep, was sunk back of the brackish water windmill. Water from this well was used for bathing and for the refrigerators.

Rain water, collected from the roofs of all the buildings except the power house, was stored in the cisterns and then pumped by the second, or fresh-water mill to the mess hall and manager's quarters. For contingencies of dry periods when the rain water becomes exhausted, three stills provide water for drinking purposes. Each still has an output of $1^{1}/_{2}$ gal per hr. At times, to remove the flat taste, the water is treated with chlorine tablets.

The preservation of food for the construction and permanent crews was a matter of prime consideration. A knock-down unit 12 ft 6 in. by 19 ft 6 in. in size, and 10 ft high, was installed in the refrigerator building. The unit was assembled and in operation in 72 hr. It consists of a freezer room for the preservation of meats and other frozen foods; a cold room, used for daily withdrawals; and a cold-storage room for vegetables. Three compressors, two for the freezer and cold-storage rooms and one for an ice-making unit, made up the refrigeration equipment.

DOCK PROVIDED

It was originally intended to drive piles for the 276 ft of dock, but the lack of necessary equipment and the problem presented by tightly compacted sand called for another method of construction. Jetting was also out of the question on account of insufficient equipment so 20-ft creosoted piles were cut into 10-ft sills, and into posts of various lengths to fit the position in the dock. Bents were made up complete on the shore, floated out over the desired location, and then sunk with the aid of from six to eight sand bags. After the first two bents were placed in position on the shore end, the sills were connected with 20-lb rails 24 ft long and lapped 12 ft. Thus 12 ft was left projecting. By sliding the next bent under the rail, each successive bent was readily fastened down. Every third bent was braced diagonally with additional rails and also held in place laterally by jetting down alongside of it two pieces of rail varying in length from 12 to 24 ft. When jetted to the desired depth these rails were bolted to the bents. The rails were spiked to the bents under water by sliding a 2-in. pipe sleeve over the spikes and then driving with a $1^1/_8$-in. steel rod 8 ft long. A compressor capable of delivering 100 lb was used to jet down the rails. For an anchor pile for the landing float, four 4-in. extra-heavy steel pipes were jetted down 15 ft by attaching air hose to a $^3/_4$-in. pipe, putting the latter inside of the 4-in. pipe, and then building up the compression to 100 lb successively. This operation required from 10 to 20 min.



PUTTING SIDING ON THE MESS HALL
Note Lack of Bracing and Rigidity of Structure

Concrete aggregates, with the exception of sand, were brought in from the United States. The fine aggregate was the natural coral beach sand, free of silica, extremely fine, with a high salt content. Standard analysis disclosed that practically none of it passed the 200-mesh sieve; about $6^1/_2$ per cent passed the No. 48 sieve; and practically all passed the No. 14 sieve. It seemed to be entirely non-absorbent of heat, due to the absence of silica. It was cool to the touch even to the tenderest of bare feet but at the same time was highly reflective, as was evidenced by some severe cases of sunburn.

With this extremely fine sand, a rich mix had to be used. That selected was $1:1^1/_2:3$. Expediency ruled and no time was available to make tests beforehand. They were made afterward as a sort of vindication of methods and mixes used. Two 6-in. test cylinders were made up, cured for 28 days in moist sand, and then broken. They showed strengths of 2,200 and 1,440 lb per sq in., or an average of 1,820 lb. The fractures were all in the mortar, none across the coarse aggregate. The coarse aggregate was $^3/_4$-in. crushed rock from San Francisco, and the average slump of the concrete was 4 in.

ICE VERSUS JACKS

Power for the project was furnished by two 240-v 3-phase 60-cycle diesel generators designed to give a continuous output of 35 kva at an 0.8 power factor. The units weighed five tons each. Suitable jacks not being available, the placing of the machines became a problem. As there was no possible way of putting beams through or under the frame, thus bringing the machine into place, only one avenue of escape remained—ice blocks, 3 in. thick, 12 in. wide, and 36 in. long were used. With the generator set over the foundation bolts, ice blocks were built up 4 layers thick for the entire base with the exception of the corners, which were occupied by the four small five-ton hydraulic jacks. When all the ice was in place, the load was transferred to it and the jacks removed. By shading, with burlap bags, and by using a blow-torch to get uniform settlement, the generators were set in place in four hours.

AIRPORT OFFICE NEARING COMPLETION—WHITE SAND SHOWS UP LIKE SNOW

For handling heavy material and grading, a three-cylinder diesel tractor with 44-hp drawbar pull was used. Supplementing it were one roll-over scraper of 42-cu ft capacity: a 30-ft boom capable of lifting 1,000 lb, with an additional sheave set in the boom at 22 ft; and an 8-in. cathead and winch. The value of this

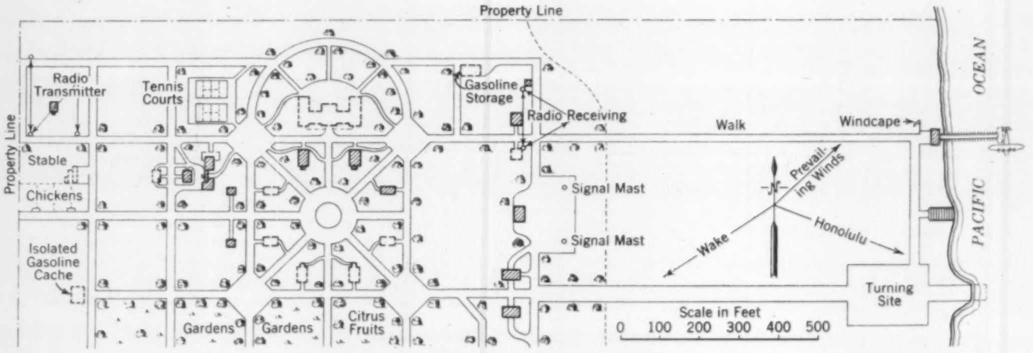


FIG. 2. MARINE AIRCRAFT BASE, MIDWAY ISLAND
Present Buildings Shown in Full Lines and Hatched; Future, in Dashed Lines

machine on the various phases of the work cannot be estimated, for it was everywhere and doing everything, even to the bringing in of the fish catches.

The construction crew consisted of six carpenters, four apprentice carpenters, two riggers, two plumbers, two electricians, and eight laborers. The men were selected for their versatility in regard to trades so that they could be moved into the various phases of the work as it progressed. For instance, one of the plumbers and one of the carpenters with painting experience became the nucleus for the painting gang. Sooner or later every man had the satisfaction of running some part of the work.

LIFE ON AN ATOLL

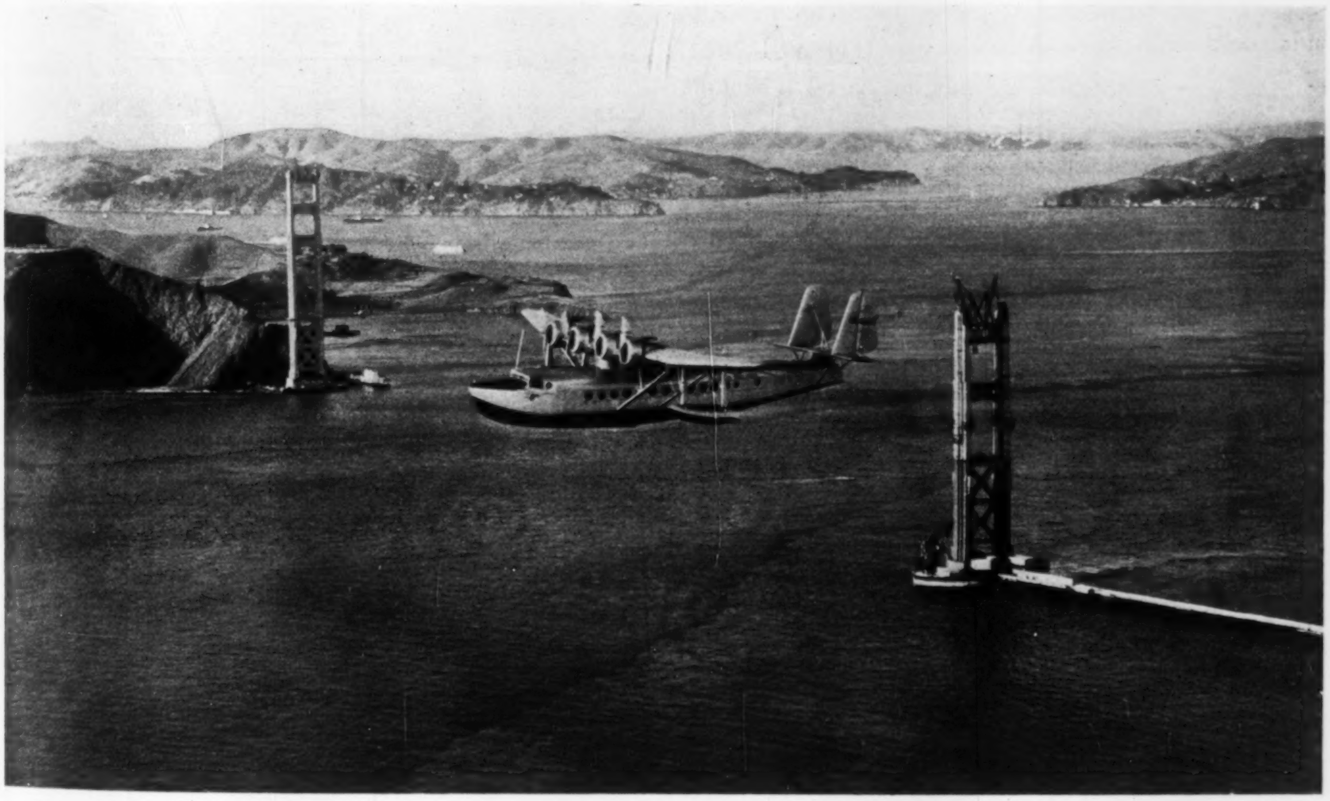
Army squad tents housed the men, four to a tent. They were large and cool. Policing of tents and grounds was done by Chinese help, leaving the men free to devote their full time to the work. Recreation was had in the form of talking cinema, baseball (soft ball), and fishing. Many a man who had never cast a line overboard before did so for the first time in the beautiful blue-green waters of the lagoon only to have the line torn from him by some denizen of the deep.

Midway Island being a bird sanctuary, spare moments offered the men rare opportunities to get acquainted with the various types of albatross, of red-tailed tropic or Bos'n bird, of boobies, man-o'-war hawks, the shearwaters, the Laysan wingless rail, and the great family of terns, of which the white tern or love bird was the most beautiful of all. Fearless, it was a never-ending wonder as it permitted the men to walk near it without paying the slightest attention to them.

Of sickness there was little. All the men were given a rigid examination in San Francisco, vaccinated for smallpox, and inoculated against typhoid. It is of interest to note that there was not one case of the common cold on the island during the construction period. One single accident occurred when one man stepped on a nail—a record to be proud of and a tribute to the carefulness of all those working on the job.

The Dock Nearing Completion

Since both Midway and Wake, the major construction projects, were off the beaten steamship lanes, it was necessary that a ship be chartered to take the required materials to these islands. Here again time was an essential factor, for the delay of a day or two would cost thousands of dollars, taking into account the chartering of the boat and the salaries of all those on board for the different projects. After the set-up was completed in New York, it was estimated that, with crews of 23 men for Midway and 44 for Wake, the expedition should take approximately four months from the time that the boat left San Francisco until it returned. How closely this program was successful, and the not unpardonable pride of those responsible, can be judged by the fact that the expedition arrived in San Francisco only one day after that planned.



Next Stop—Hawaii

The "Pan-American Clipper," Trail Blazer for the "China Clipper," Passes the Last Landmark on Its 2,400-Mile Flight Across the Pacific. On Each Side Appear Towers of the New Golden Gate Bridge, San Francisco

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Stress Analysis of Monolithic Rectangular Concrete Conduits

By Leonard L. Longacre, Assoc. M. Am. Soc. C.E.

Deputy County Surveyor, Los Angeles County, Alhambra, Calif.

This article is presented to bring to the attention of designers the ease and rapidity with which a complete stress analysis of a monolithic rectangular concrete conduit can be made with the aid of the slope deflection equations.

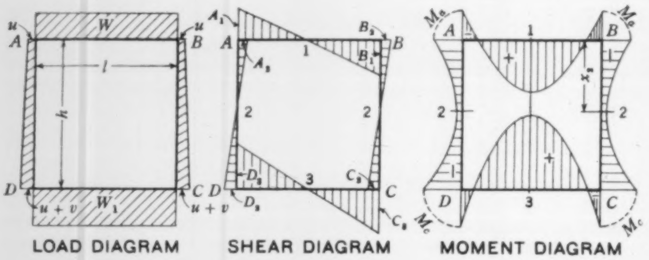


Fig. 1. Loads, Shears, and Moments in Single Box Culvert

A general loading diagram for a single box conduit is given in Fig. 1(a). The resulting shears and moments are shown in Fig. 1(b) and (c), and Fig. 2 shows similar diagrams for a double box conduit. The following nomenclature is applicable:

l = clear inside width of one barrel of conduit, in feet
h = clear inside height of conduit, in feet
W = total load on top of a conduit between side walls, in pounds per foot length of conduit
W_1 = total load on bottom of conduit, between side walls, in pounds per foot length of conduit
u = intensity of horizontal loading at top of conduit, in pounds per square foot
$u + v$ = intensity of horizontal loading at bottom of conduit, in pounds per square foot
M_a, etc. = corner moments, in pound-feet per foot length of conduit
I_1, etc. = moments of inertia of the various members, in inches^4
x_1, etc. = distance from the indicated inside face to the location of the maximum positive (or minimum negative) moment in the various members
A_1, etc. = shear at point A in member 1, etc., in pounds per foot length of conduit

Consider first the analysis of the single box conduit, loaded as shown. The following constants must first be computed.

$$K_1 = \frac{I_1}{l};\ K_2 = \frac{I_2}{h};\ K_3 = \frac{I_3}{l};\ n = K_1K_2;\ r = K_1K_3;$$
$$s = K_2K_3;\ c = 4(3K_2^2 + 2n + r + 2s)$$

These constants are to be substituted in the following equations for M_a and M_c, which have been derived by slope deflection methods:

$$M_a = \frac{5(3K_2^2 + 2s)Wl - 5nW_1l + 5(3n + r)uh^2 + (7n + 2r)vh^2}{15c}$$

$$M_c = \frac{-5sWl + 5(3K_2^2 + 2n)W_1l + 5(r + 3s)uh^2 + (3r + 8s)vh^2}{15c}$$

(For uniform load on the side walls, v is zero and the terms containing v vanish. If the side loading is triangular, u is zero.)

The shears can now be computed:

$$A_1 = B_1 = \frac{W}{2}$$

$$A_2 = B_2 = \frac{M_c - M_a}{h} + \frac{(3u + v)h}{6}$$

$$C_2 = D_2 = \frac{M_a - M_c}{h} + \frac{(3u + 2v)h}{6}$$

$$C_3 = D_3 = \frac{W_1}{2}$$

The maximum positive moments in the top and bottom members are at the midpoints, and are the maximum moments for a fixed beam corrected by the corner moments already computed:

$$M_1 = M_a + \frac{Wl}{8}$$

$$M_3 = M_c + \frac{W_1l}{8}$$

Whether the moment near the midspan of the vertical members is positive or not depends on the ratio of the horizontal load to the vertical load. The location of

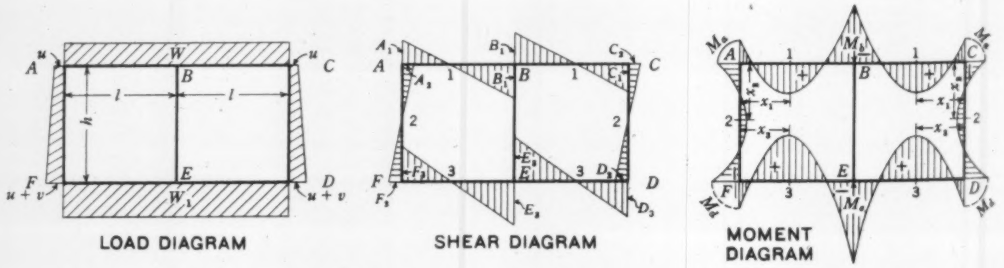


Fig. 2. Loads, Shears, and Moments in Double Box Culvert

this maximum positive (or minimum negative) moment, measured from the inside top of the conduit, is

$$x_2 = \frac{\sqrt{2hvA_2 + h^2u^2} - hu}{v}$$

and the magnitude and sign of this moment are given by

$$M_2 = M_a - \frac{ux_2^2}{2} - \frac{vx_2^3}{6h} + A_2x_2$$

In this analysis all signs have been taken care of automatically. A positive value for a corner moment indicates clockwise rotation of the joint, and a positive value of a beam moment indicates tension on the inside face of the conduit. In plotting the shear and moment diagrams of Fig. 1, the frame is considered to be cut at the lower left-hand corner and unfolded to make a continuous beam. Positive shears are plotted upward from the base line and positive moments downward.

The analysis of the double box conduit (Fig. 2) is quite similar. We begin by computing K_1, K_2, K_3, n, r, and s, as before. The expression for c in this case is $4[3k_2^2 + 4(n + r + s)]$. The corner moments can now be computed.

$$M_a = \frac{5(3K_2^2+4s)Wl - 10(n)W_1l + 20(3n+2r)uh^2 + 4(7n+4r)vh^2}{30c}$$

$$M_d = \frac{-10(s)Wl + 5(3K_2^2+4n)W_1l + 20(2r+3s)uh^2 + 4(6r+8s)vh^2}{30c}$$

$$M_b = \frac{-5(3K_2^2+6n+6r+4s)Wl - 5(n)W_1l + 10(3n+2r)uh^2 + 2(7n+4r)vh^2}{30c}$$

$$M_e = \frac{-5(s)Wl - 5(3K_2^2+4n+6r+6s)W_1l + 10(2r+3s)uh^2 + 2(6r+8s)vh^2}{30c}$$

For the shears we have:

$$A_1 = C_1 = \frac{M_b - M_a}{l} + \frac{W}{4}$$

$$B_1 = \frac{M_a - M_b}{l} + \frac{W}{4}$$

$$A_2 = C_2 = \frac{M_d - M_a}{h} + \frac{(3u + v)h}{6}$$

$$D_2 = F_2 = \frac{M_a - M_d}{h} + \frac{(3u + 2v)h}{6}$$

$$E_3 = \frac{M_d - M_e}{l} + \frac{W_1}{4}$$

$$D_3 = F_3 = \frac{M_e - M_d}{l} + \frac{W_1}{4}$$

The distances from the inside of the outer wall to the locations of maximum positive moments in the top and bottom members are respectively, $x_1 = \frac{2A_1l}{W}$ and $x_3 = \frac{2D_3l}{W_1}$ and the moments are

$$M_1 = M_a - \frac{Wx_1^2}{4l} + A_1x_1, \text{ and}$$

$$M_3 = M_d - \frac{W_1x_3^2}{4l} + D_3x_3.$$

In the side walls the maximum positive (or minimum negative) moment occurs at a distance $x_2 = \frac{\sqrt{2hvA_2 + h^2u^2} - hu}{v}$ from the top and is

$$M_2 = M_a - \frac{ux_2^2}{2} - \frac{vx_2^2}{6h} + A_2x_2,$$

the sign being taken care of automatically. As the loading is symmetrical there is no moment in the central vertical member.

In plotting the shear and moment diagram of Fig. 2 the frame is considered cut at the bottom of the center support and unfolded to left and right.

Simplified Method of Graphic Analysis

By Thomas James Higgins

Instructor in Engineering, Wyomissing Polytechnical Institute, Reading, Pa.

In recent years the use of a new graphical method for determining forces in structural members has become widespread in England. Easily understood, exceedingly simple to work with, and giving the desired information more quickly than methods commonly in use at present in the United States, it is admirably suited for engineering purposes and at present bids fair to supplant the current use of the functional polygon. In addition, it lends itself readily to pedagogical treatment, for basically it is but a graphical counterpart of the algebraic determination of these stresses.

In the algebraic method, simultaneous equations are solved to find the desired forces. An analysis of the method here presented will show that it is exactly equivalent to this algebraic process.

The method is founded upon a single basic construction, namely, a certain graphical representation and determination of the moment of a force about any point. Using Bow's notation (Fig. 1) let p be any point and RS the line of action of any force. Join r and s, the end points of the vector representing RS in direction and magnitude, to p and extend RS until it intersects pr and ps in r' and s', respectively.

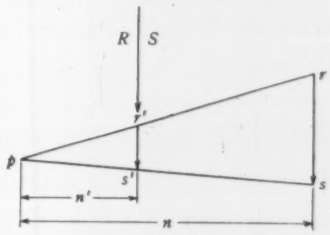


Fig. 1. The Basic Construction

By definition, the moment of RS about p is the product of RS and the normal distance from p to RS. Thus the graphic moment of RS is found to be the product of n' and rs. By similar triangles,

$$\frac{r's'}{n'} = \frac{rs}{n}, \text{ or } n \times r's' = n' \times rs$$

Therefore, the product of the intercept and the normal distance to the load line ($n \times r's'$) is likewise the moment. Further, to a certain scale, $r's'$ itself is equal to the moment. This scale is the product of the scale of force, the scale of length, and the reciprocal of the plotted normal distance from p to the line of loads. For example, if the length of $r's'$ is 2 in.; the length of n, 3 in.; the scale of force, $^1/_6$ (1 in. = 6 lb); and the scale of length, $^1/_{10}$; then the moment is $(2 \times 6)(3 \times 10)$ or 360 in.-lb. But to a scale of 1 in. = 180 in.-lb ($^1/_{180} = {}^1/_6 \times {}^1/_{10} \times {}^1/_3$), $r's'$ represents this moment.

To find the resultant of several parallel forces, a similar procedure is followed. Figure 2 illustrates a beam, supported as shown, and acted upon by several parallel forces. This construction is applied to determine, first the magnitude and location of the resultant of these forces, and second, the reactions at the supports.

For convenience set out the line of loads through the right-hand support. Next, determine each of the various intercepts representing the individual moments, taken about the left-hand support, of the respective loads. Since the magnitude of the resultant of a number of parallel forces acting in the same direction is equal to their sum, *ru* is the vector resultant. Further, this resultant must produce a moment about *p* equal to the sum of the individual moments. Now since the intercepts, to a certain scale, represent the corresponding moments, they can be added together to obtain *r'u'*, the moment vector of the resultant.

To find the line of action of the resultant, the procedure detailed in discussing Fig. 1 is merely reversed. Set *r'u'* on the line of loads, with *r'* coinciding with *r*, and from *v* (the position of *u'*) draw a line parallel to *pr* and cutting *pu* in *v'*. The resultant passes through this point, has the magnitude and direction *ru*, and a moment about the left-hand support of magnitude *r'u'*.

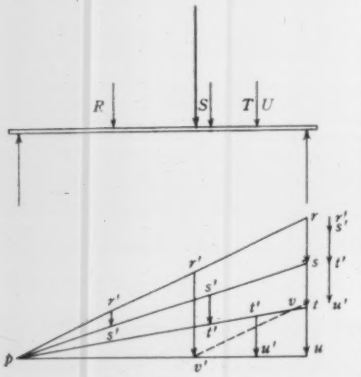


FIG. 2. DETERMINING THE RESULTANT OF SEVERAL PARALLEL FORCES

Inasmuch as this construction is perfectly general, it can be applied to finding the resultant of any system of parallel forces.

To determine the reactions at the supports, note that the moment of the resultant and the moment of the right-hand reaction, each taken about the left-hand support, must be equal if the beam is at rest. Therefore the moment of the right-hand reaction about the left support is *u'r'*. Consequently, the right-hand reaction itself is *vr*, while the left-hand reaction must be *uv*.

A kindred problem is faced in finding the reactions at the supports of a structural member indirectly acted upon by a number of non-parallel loads (Fig. 3). This member may be considered as a beam, supported and loaded in the manner illustrated. Since in this particular case the horizontal components of force have no moments about a support—they lie in the line of the member under consideration—if the forces are resolved into horizontal and vertical components, the problem is reduced to that just considered and is easily solved.

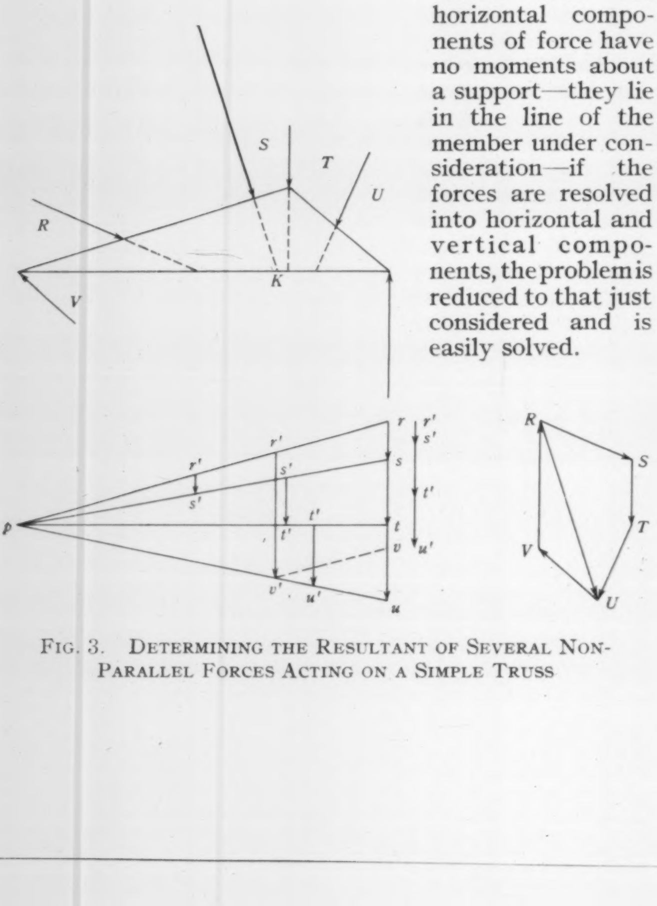


FIG. 3. DETERMINING THE RESULTANT OF SEVERAL NON-PARALLEL FORCES ACTING ON A SIMPLE TRUSS

Draw the usual force polygon *RSTUR* and project the vertical components upon the load line, here taken through the right-hand support. As before, determine *K*, through which point the resultant passes parallel to *RU*, and determine *uv* and *vr*, respectively the vertical components of the left-hand and right-hand reactions. Assume that the right-hand support is a roller; then the reaction there has only a vertical component, and the force polygon of Fig. 3 is obtained.

An important application of this method, and one that admirably illustrates its possibilities in practical work, is its use in determining the forces in the members of trusses and similar structures by the method of statistical moments. As is well known, this method consists in taking a section through the structure so that not more than three members will be cut. Since the structure is at rest, both of the parts thus obtained must also be in equilibrium. By taking moments about the intersection of two of the severed members, it is possible to determine the force in the third.

To find the force in the member *FD* of Fig. 4, the constructions previously developed are used. To enable interested readers to make a definite evaluation of the usefulness and inherent simplicity of the method presented in this article, as well as to make clear how accurate it is, Fig. 4 has been taken from a well-known source, *Kent's Mechanical Engineers' Handbook*, Fig. 16, page 575.

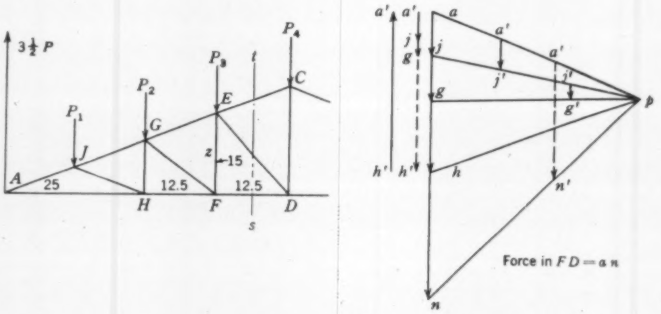


FIG. 4. APPLICATION OF THE SIMPLIFIED GRAPHICAL METHOD TO A PROBLEM IN TRUSS ANALYSIS

Setting out the line of loads through the left support and constructing the force polygon as usual, it is found that the loads acting on the part of the structure to the left of the section line *st* have a combined moment about *E* of *a'g'*, while the reaction at the support has a moment of *h'a'* in the opposite direction. If the structure is in equilibrium the force in the member *FD* has a moment about *E* equal to the difference between the two, or *g'h'*. Since this force acts at the distance *EF* from *E*, it can be determined at once by laying off *a'n'* equal to *g'h'*, at a distance *EF* from *p*, extending the line *pn'* to intersect *ah* extended at *n*, and scaling the length *an*. The computed force is 6.25 *P*: it scales the same.

The method here described offers a number of advantages. The moment diagrams can be immediately constructed when the intercepts have been found. It lends itself readily to problems such as beams with a number of concentrated loads, or to other problems where awkward numerical values would make the algebraical solution tedious. It is easier and quicker to manipulate than the graphical methods now employed.

It is hoped that the presentation of this method, here published for the first time in an American periodical, so far as the author is aware, will lead to its adoption and use by practicing engineers, an end it obviously merits.

Measurement of Clearance for Tunnel Lining

By E. L. Cranford

Chief of Inspectors, Division No. 6, Metropolitan Water District of Southern California, Los Angeles, Calif.

PLANS for the tunnels of the Colorado River Aqueduct specify a minimum thickness of concrete lining. In rock sections where support is not required, heading excavation is governed by two reference lines. The "B" line is the outside limit to which payment for excavation will be made, and the "A" line is the minimum clearance line, or line representing the minimum thickness of concrete lining which will be required or permitted.

In attempting to confine rock excavations to the "B" line, heading crews frequently leave areas or points of tunnel wall and roof projecting for short distances inside the "A" line. Before lining forms are set, these areas or points must be located and removed. For this purpose the "junior jumbo" was developed and used in the tunnels of Division No. 6 of the Metropolitan Water District of Southern California.

The apparatus, as shown in Fig. 1, consists principally of a light tram car, two measuring rods, and two hanging rods. The hanging rods are graduated so that they may be adjusted to hang to the tunnel axis, or control line, from center-line spads of various elevations.

The tram car is built in two parts so that it can be removed from the track by two men when necessary to permit passage of regular tunnel traffic. The lower part is a flat car of hollow tubing on ball-bearing crane wheels which were salvaged from a defunct Pittsburgh jumbo drill carriage. The upper part of the car is a platform raised to a sufficient height above the flat car to bring the eyes of a person on the platform to about the level of the tunnel axis.

Mounted on the front of this platform is a round upright arm held, and allowed to swing laterally, by a bolt and wing nut. This arm supports a sleeve which will revolve in a plane normal to the tunnel axis, and which has a peephole paralleling the tunnel axis. It can be moved sideways by swinging the vertical arm, and vertically by means of an adjustable clamp on the arm.

The hanging rod marked *C* in the figure is adjusted so that the light from an ordinary flashlight mounted in brackets on the back of the rod is reflected horizontally by a diagonal mirror through a $^1/_2$-in. hole at the tunnel axis. The rod *D* also has a $^1/_2$-in. hole at the tunnel axis and is equipped with a disk about this opening which enables the operator of the device, when his eye is near the tunnel axis, to see only the light rays from rod *C* that pass through the peephole in rod *D*. Rod *C* is also equipped with a similar disk to blot out other lights in the tunnel which, in perspective, appear to the operator to be on the tunnel axis. This difficulty may also be overcome by using a colored lens on rod *C* to distinguish its light.

With rods *C* and *D* in place and adjusted to hang from roof spads of known elevations, so that the light on rod *C* and the peephole in rod *D* are exactly on the tunnel axis, the revolving sleeve on the platform can be brought to the tunnel axis by sighting through the opening provided therein and lining it in with the rays coming through the peephole in rod *D* from the light on rod *C*.

The "A" line of the Colorado River Aqueduct tunnels is a compound curve, the section above the springing line being a semicircle, and the walls being arcs described about the intersection of the springing line with the roof arc.

Rod *A* is designed to slide inside the revolving sleeve and is graduated to read zero at the sleeve eyepiece when the end of the rod is on the "A" line, and directly in inches when partially withdrawn to permit revolving past a "tight" point.

Rod *B* is graduated to show horizontal distances to the wall "A" line at 1-ft intervals below the springing line. These 1-ft intervals are indicated by markers on a plumb line suspended from the sleeve support. Amounts of wall projections can be estimated, or measured at the plumb line with a rule.

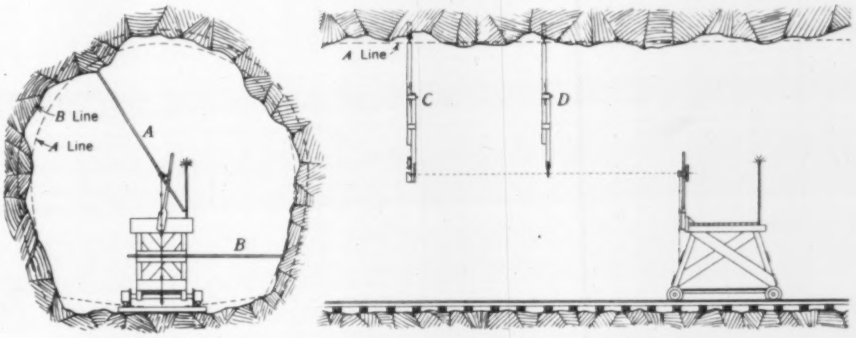
An electric light, with a 100-ft cord for connection with the regular tunnel lighting circuit, is provided where additional illumination is desired.

If the distance between the tram car and rod *D* is no greater than the distance between the hanging rods, the accuracy of the setup is within a reasonable tolerance. Very accurate results can be obtained by confining these two distances to no more than 100 ft each, and by paying attention to the distribution of light rays coming through the peephole on rod *D*. If the majority of the rays appear on one side of this peephole, a shifting of location of the eyepiece on the revolving sleeve to a position from which the rays appear to be equally distributed radially, is conducive to even greater accuracy.

Because of its flexibility, the junior jumbo can be used on tunnel tracks with wide variance from line and grade, and by providing additional mountings for the vertical arm near the sides of the car, it can be used as well from sidings and passing-tracks.

The accompanying diagram shows the junior jumbo in actual use in the Bernasconi Tunnel where a "tight" spot on both wall and roof was found. The actual "A" line was painted around the area, and the depth to be cut was indicated therein by means of paint brushes mounted on long and (according to the wielders) heavy handles.

The accuracy and speed of operation and the low cost of construction are the principal factors contributing to the practicability of the junior jumbo. I conceived and developed it in actual practice and am at present considering further improvements and refinements.



CROSS SECTION LONGITUDINAL SECTION

Fig. 1. The "Junior Jumbo," for Measuring Clearance in Tunnel Cuts
This Apparatus Demonstrated Its Value in Several Colorado River Aqueduct Tunnels

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Members Comment on Membership Grades

To the Editor: I should like to express my opinions on the subject of changes in membership grades. If a change is desired, why not abolish the name Junior instead of that of Associate Member?

Surely there are many engineers less than 27 years of age who are worthy of a much higher classification than that of Junior. Such a change would make 30 the minimum age of members, and the qualifications would be three years in responsible charge of work and ten years in active practice. For Associate Members the minimum age would be 20 years. The fees would be as for present Juniors until the age of 30. After that they would be the same as for members.

If, in some future time, it is desired to have a higher grade than Member quite apart from the present Honorary Members, a new group of Honorary Life Members might be created—not to exceed 200 in number and to be selected, by the Board of Direction, from those who have paid dues for 35 years or more.

T. Kennard Thomson, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
November 29, 1935

To the Editor: The object of creating the grade of Fellow (which is generally understood to be senior to Member) was to pull up to the American Institute of Electrical Engineers in its more pretentious designation. I am opposed to this for the same reason that I would dislike to see all captains made admirals, all commanders made captains, etc., on the ground that that is how it is in the Mexican navy.

Standardization is no doubt desirable. There is some confusion between captains in the navy, in the army, and in the police force. But not much.

But standardization by inflation is undesirable. So, of course, is that by deflation; but it would be better for the American Institute of Electrical Engineers to make no more Fellows, and to advance by one year every two years the age for Member, until reaching the limit of 35, and so gradually come into line with our Society, than to ask us to make a "mass promotion," which could not possibly avoid having the effect of an invidious demotion on large numbers of present members. It is a good principle in personnel legislation to avoid all suggestion of retroaction; take away nothing, but be more conservative in future.

Or if we must be the ones to make the change, elect 50 Fellows a year, from the Members, on merit only; 200 Members from the Associates; make no new Associates; and after a reasonable time, start making Juniors into Members directly, thus gradually eliminating the Associates.

W. P. Roop, M. Am. Soc. C.E.
Lieutenant Commander (C.C.) U.S. Navy
New York Shipbuilding Company

Camden, N.J.
Dec. 6, 1935

Stevens Stamp Is Canal Zone Issue

Dear Sir: An item in the news section of your December 1935 issue relative to the postage stamp to be issued containing my photograph fails to mention one significant detail. This is not to be a United States stamp but is rather a Canal Zone issue. I think the distinction is important.

John F. Stevens,
Past-President and Hon. M. Am. Soc. C.E.

Baltimore, Md.
December 10, 1935

Some Suggestions on Modern Steam Plants

To the Editor: In his article on "Recent Advances in Steam Plant Design," in the September issue, Professor Eyre has covered an extensive and difficult subject in a very satisfactory manner. He mentions the fact that the great loss in efficiency in a steam plant is due to the large difference in temperature between the furnace and steam. This statement, no doubt, is meant to apply to furnace and boiler efficiency and not to the efficiency of the plant as a whole. The greatest single loss in a steam plant is the amount of heat that must be discharged with the circulating water, and the next greatest is the amount that is lost in the stack gases. A steam plant operating at a pressure of 450 lb and 750 F will probably have a thermal efficiency of 26 per cent. This means that the total losses amount to 74 per cent of the heat value of the fuel, and of this approximately 14 per cent is lost in the stack, 56 per cent in the circulating water, and the remainder is made up of miscellaneous small losses. Higher steam pressures and temperatures and the use of air preheaters and economizers tend to reduce these losses, but under the best conditions known today the total losses amount to approximately two-thirds of the heat supplied in the form of fuel.

In many localities hydro-electric power can be depended on as the sole source of energy. However, in the Southwest where rainfall is very uncertain, it is necessary to have standby steam plants to supplement the water power. In some instances the total generating capacity of a large system will be almost equally divided between steam and water power and the amount of power generated by steam will vary from 10 to 50 per cent or more, depending on the rainfall.

One of the important items to be considered in the steam standby plant is the rapidity with which it can pick up load when an outage occurs on the hydro-electric system. Some interesting experiments were made recently on the 100,000-kw steam turbine to determine the speed with which load could be picked up. This unit was floating on the line with a load of not more than 1,000 kw and was able to pick up 85,000 kw almost instantly. This rapid increase in load naturally resulted in a drop in boiler pressure, but it was found that full boiler pressure was restored and a 100,000-kw load was being carried by the unit within $4^1/_2$ min. This is the type of performance that is required of an adequate steam standby plant.

Harold L. Doolittle, M. Am. Soc. C.E.
Chief Designing Engineer, Southern
California Edison Company, Ltd.

Los Angeles, Calif.
November 30, 1935

Water Supplies Polluted by Back Siphonage

To the Editor: The obligation of the engineer to protect the lives and property of the public has long been recognized, and in recent years his responsibilities with regard to the protection of public health have become much greater. Much has been written on the general subject of pollution of water supplies, and it is believed that the profession has made giant strides in safeguarding the public health in this respect. Federal, state, and municipal governments have enacted laws on the subject to protect public health, and the situation throughout the country is well in hand.

However, while considerable information and research data are available on the subject of the contamination of water supply through cross connections, little seems to have been done either by the various health departments or other agencies to proscribe the chief sources of such pollution. I am advised by the New York

State Conference of Mayors that there is no ordinance in their records from municipalities outside the City of New York expressly forbidding certain fixtures well known for their liability to siphonage.

It is obviously the duty of the architectural and engineering professions to take the initiative in the matter. The proper design of plumbing and drainage systems and the elimination from specifications of various types and fixtures and apparatus, which have been proved to be dangerous, are clearly the functions of the engineer.

In 1934 the Wisconsin State Board of Health, in conjunction with the Department of Hydraulic and Sanitary Engineering of the University of Wisconsin, issued a valuable treatise entitled "Cross Connections in Plumbing and Water Supply Systems." In 1931 the research committee of the American Society of Sanitary Engineering published a report on the subject of cross connections, and a similar article appeared in the January 1929 issue of the *Plumbers and Heating Contractors Trade Journal.*

Much other material on the subject has also been published. Despite these data, the manufacturers of plumbing fixtures continue to advertise and sell various types of fixtures, notably the one-piece low-down toilet combination where the flush tank and bowl are in one piece, with the flushing rim of the bowl actually higher than the inlet to the tank.

Various types of flushometers are also in the same category, as is revealed in the report of the official tests made at Chicago in September 1934, by a committee consisting of members of the Chicago Board of Health and various representatives of master plumbers associations and manufacturers. The results of these tests have resulted in the manufacturers' offering vacuum breakers in connection with their valves, but they are furnished only when specified or required by local ordinance.

Such items as water-primed cellar drainers, swimming pool recirculating systems, restaurant and bar-sink washers, and miscellaneous hospital fixtures are clearly condemned in their present design by the various investigations just mentioned.

As previously stated, rigid steps have been taken to protect our water supplies at the source, and some further safeguards have been set up, as in New York State, covering cross connections between private and public water supplies. But the question of ruling out, by legislation or other means, all types of fixtures and installations which violate the basic principles of protection against back siphonage seem, except in isolated cases, to have been entirely disregarded by public officials of our various governmental agencies.

Engineers charged with the planning of all types of buildings, especially those for the manufacture of food products, should be thoroughly advised on this question, and to my mind the greatest possible publicity should be given the entire subject.

F. L. Moore, M. Am. Soc. C.E.
Building Inspector, Village of Garden City, N.Y.

Garden City, N.Y.
December 8, 1935

Need for Cooperation Among Engineers

To the Editor: In the list of New York State, County, and Village Civil Service Examinations, to be held December 14, 1935, there is included an examination for assistant bridge engineer, in the Office of the County Superintendent of Highways, Ulster, N.Y. The detailed announcement of duties and qualifications follows:

"228. *Assistant Bridge Engineer,* Office of the County Superintendent of Highways, Ulster County. One appointment expected at 80 cents per hour. Preferred maximum age 40 years. Duties: Under general supervision, to inspect, measure, and compute stresses for determination of the carrying capacity of existing steel and concrete bridges; to design and draw plans for new bridges; to make bridge surveys, lay-outs, and superintend the construction of bridges; and to do related work as required. Candidates must meet the requirements of one of the following groups: Either (1) not less than four years of satisfactory experience on the design, detailing, or construction of steel and reinforced concrete bridges, of which not less than $1^1/_2$ years must have been on designing, and 1 year in construction of bridges; or (2) graduation in civil engineering with a degree from an institution of recognized standing and two years of satisfactory experience in the design, detailing, or construction of steel and reinforced concrete bridges, of which not less than one year must have been on designing and one year in construction of bridges; or (3) a satisfactory equivalent combination of the foregoing education and experience. Subjects of examination: Written examination on the knowledge and skills involved in performing the duties, relative weight 4. For use in the examination candidates should bring standard engineering handbooks."

It is evident that the title, the duties, and the qualifications all call for a licensed professional engineer, and applicants should be required, as a matter of course, to be licensed. But the important thing about the position, the feature that stands out above everything else, is that the pay will be 80 cents per hour. Some highly trained and well-educated professional man will be expected to work on an hourly wage basis, like a laborer or a tradesman, and at a wage that no self-respecting trades union would permit one of its members to accept.

The tragic thing about it is that plenty of qualified engineers can be found willing to accept such jobs, eager to compete against each other for them, in fact, while their brother engineers stand smugly by and do nothing about it.

Whose fault is it, in this particular case, that such a disgraceful state of affairs is permitted to exist? It is not entirely the fault of the Ulster County Superintendent of Highways, who is probably restricted by the requirement of not exceeding his appropriation. It is not entirely the fault of the State Civil Service Commission. Least of all is it the fault of the engineer who is driven by necessity to compete for such a position.

There is nothing unusual about it. Similar cases occur every day. What can be done about this sort of a thing? I am not by any means convinced that the principles of trades unionism would be the proper thing for engineers. As a matter of fact, I have no idea as to what would be the proper thing for engineers. But until the brains of the engineering fraternity tackle this problem in the same scientific and effective way that they go after complicated technical problems; until learned engineering societies concern themselves with the humanities as well as the technicalities of their profession; until the individual engineer begins to cooperate with his fellow engineers; until these things happen, engineers, as a class, will continue to get little benefit from their conceded contributions to modern civilization.

Richard M. Hodges, M. Am. Soc. C.E.
Assistant Engineer, Westchester County Park Commission

White Plains, N.Y.
December 3, 1935

Book on Beam Deflection Formulas Suggested

Dear Sir: On page 643 of the October issue of Civil Engineering Robins Fleming makes a good and timely reference to the need for a book on beam deflections. There is need for such a book, well gotten up, with uniform standard notation throughout, and suitable line cuts. It does not need to be a large volume, but I hope that the authors will include graphic as well as numerical methods, and will also cover the cases of varying sections of the beam (such as engine shafts composed generally of different lengths of cylindrical elements of varying cross section connected by filleted steps), of varying concentrated loads, and of more or less uniform loads. Such a book should treat of the effect at the ends of the piston strokes, inertia of moving parts, and similar factors, since the piston may give a plus load when under pressure or a minus load when stopping.

I hope, too, that the book will include the deflections of frames, such as the steel frames of a building, with the wind at 90 deg to one wall, also when the wind impinges at other angles. Articles on such cases have been published, but they are scattered and hard to find quickly. Also of interest would be a discussion of the bending stresses and deflections of the shaft of gasoline engines, such as the 4, 6, and 8 cylinders, vertical and V-types, and vertical Diesel engines.

Frederick W. Salmon
Civil and Mechanical Engineer

Birmingham, Ala.
December 5, 1935

Plea for Additional Studies of Runoff Cycles

DEAR SIR: I wish to submit a few comments on "Variations in Runoff of California Streams" by S. T. Harding in the September issue of CIVIL ENGINEERING.

One of the main points established by Professor Harding's investigations in the Great Basin area seems to be that it has been possible to determine with some accuracy that, during the past 75-year period, runoff in that area has been better than it was during the preceding 200 or 300 years. During this period, cycles of deficiency were probably not as severe as those in the earlier period. Tree records have shown clearly that lakes were continuously lower for from 150 to 200 years prior to 1860, and indications are that mean inflow in that long period was less than 60 per cent of the mean for the past 34 years. Direct stream records available for the latter period show that runoff and lake levels reached a peak about 1916, which is higher than any peak since about 1840. Since 1916 the trend has been downward, the more recent years showing a very marked decline.

Professor Harding points out that there are considerable climatic differences between the western and eastern parts of the Great Basin. Also, he emphasizes the fact that caution should be used in applying conclusions regarding past fluctuations to outside areas, as well as in applying such conclusions to probable future fluctuations, because trends or cycles in these or other climatic records from which future variations may be predicted have not been found.

It is a fact that whatever has occurred in the past may occur again. Therefore the institution of similar investigations in certain other parts of the Western states and the prairie provinces of Canada would produce valuable data, especially at a time when problems of drought, conservation of moisture, and water supply are receiving particular attention from governments, which have already appropriated large sums of money for investigation and the construction of works to relieve the very serious condition.

In considering the effect of the recent dry period on large areas of cultivated land in regions of insufficient rainfall, it does not take much imagination to visualize what would have been the effect of a prolonged cycle of drought occurring a century or so ago on these western plains, if cultivation had been as intensive as it is today. Also, when it is remembered that proud cities of ancient civilization now lie buried beneath the desert sands of what once were fertile plains, it is apparent that the value of such studies is inestimable.

G. P. F. BOESE
Department of Natural Resources
Canadian Pacific Railway Company

Calgary, Alberta
December 7, 1935

Comments on Physiography of Los Angeles Area

TO THE EDITOR: In the September issue A. L. Sonderegger has given an excellent description of the physiography of the Los Angeles area. Perhaps a more detailed description of one of the interior valleys will show its relative importance in the development of the entire region.

The San Fernando Valley is a typical interior valley basin, with a total floor area of approximately 113,000 acres, enclosed by hills, having but one constricted outlet or "narrows" through the intermediate range of hills to the coastal plain. The hills forming the boundaries of the valley, are almost entirely of sedimentary origin. Streams from these ranges are small and of intermittent flow. The westerly part of the valley fill consists of a heavy, closely compacted material suitable for many types of agricultural use.

Granitic sands and gravels, deposited by the Pacoima, and the Big and Little Tujunga creeks, compose the easterly part of the valley fill. These streams are typical of a semi-arid climate in that they have flash flows during the rainfall season, capable of carrying tremendous loads of eroded material.

As a result of this method of deposit, the upper part of the valley consists of a coarse material, which grades off to fine sands and silts in the lower areas.

At the south edge of the valley flows the Los Angeles River. The streams from the Sierra Madre Mountains, passing as surface flows across the valley, make a surface connection with this river for only a few days during flood peaks. As soon as the peak has subsided, the downward movement into the alluvial fill absorbs the surface flow in the upper part of the valley. This natural phenomenon has been put to excellent use by the artificial spreading on these gravel areas, not only of local waters released from flood control reservoirs but also of imported waters. Filtering downward, the waters thus entering the valley fill flow underground in a southeasterly direction towards the "narrows" to join the Los Angeles River and, unless otherwise diverted, flow out through the narrows onto the coastal plain.

During cycles of heavy rainfall, the gravels of the easterly area act as a sponge, retaining large quantities of water which maintain the Los Angeles River during subsequent periods of drought, and establish an equilibrium that could never be obtained by the construction of surface storage basins. During periods of above-normal rainfall, the water absorbed results in a high water-table which holds back water that would normally flow from the western part, thereby causing a rise in the water-table of that area. A subsequent dry period results in a lowered water plane in the eastern section, which allows the ground waters of the western part to feed in an easterly direction, thus maintaining a constant and uniform flow in the Los Angeles River.

SUMMER FLOW OF THE LOS ANGELES RIVER ABOVE DIVERSIONS

During the past 15 years, the diversion of domestic water by the City of Los Angeles in the southern part of the valley has averaged 69.6 cu ft per sec, in addition to the diversion made by the cities of San Fernando, Glendale, and Burbank.

Serious results of the drought of 1924 were averted by Los Angeles only by the rapid drilling and equipping of a battery of wells, having a combined capacity of 100 cu ft per sec, in the easterly part of the valley. In the plan to use the ground-water basin for the storage of imported Owens River water, this group of wells plays an important part.

In 1930, after three years of tests, a spreading area was constructed on the debris cone above the wells. Water put under ground at the spreading area during the winter season may be recovered the following summer by the operation of the emergency wells. If the water demand is such that it is unnecessary to operate the wells, the water will continue to move underground and be available as a gravity diversion in the lower part of the valley.

During the four-year period in which the spreading of imported water has been practiced, a total of 117,000 acre-feet has been put under ground. Absorption rates are in excess of 6 ft in depth per day. A recent study of the storage capacity of the valley fill for a zone averaging 100 ft in thickness, at the 1933 water-table, was computed to be 817,000 acre-feet.

Functioning as a regulating reservoir for irrigation return waters and local stream flow, and a storage basin for imported waters, the San Fernando Valley basin is of inestimable value to the water supply of the City of Los Angeles.

D. A. LANE, Assoc. M. Am. Soc. C.E.
Department of Water and Power
City of Los Angeles

Los Angeles, Calif.
November 24, 1935

Feasibility of the Use of a Barrier to Exclude Salt Water

TO THE EDITOR: Having a project for a salt water barrier under consideration, I was much interested in the article by Edward Hyatt, M. Am. Soc. C.E., in the September issue of CIVIL ENGINEERING, and in the subsequent discussion. It is claimed that the salt water barrier is not technically feasible. This presumably means that complete exclusion of salt water is not possible on account of back leakage through the locks. The barrier is, of course, technically feasible in many forms; it exists in nature and is built artificially on a very large scale. It is in successful operation. Back leakage of salt water does not matter as long as there is enough of a fresh supply to offset it.

A good natural example of a salt water barrier is found in the Caspian Sea. That inland sea maintains a low salinity, although it has no outlet. All its salt is deposited in the Sea of Karabogas, with which it is in open connection. The Sea of Karabogas has a very high salinity, comparable to that of the Great Salt Lake, and it acts as the "freshening basin" of the Caspian Sea.

There are many artificial salt water barriers that have been in operation for centuries. In the Netherlands much of the land is below sea level, some of it to a depth of 25 ft, and if salt is found in Gatun Lake 80 ft above sea level, much more back leakage may be expected through locks leading into canals 25 ft lower. The largest locks in the world are to be found in the Amsterdam–North Sea canal. Nevertheless, in the Netherlands no general contamination with salt has occurred through the centuries, owing to the plentiful supply of fresh water to offset back leakage; and there is no danger that the Chagres River will ever flow into a salt Gatun Lake.

Of much interest is a recent paper read by V. J. P. de Blocq van Kuffeler, director of the Zuyderzee Works, before the Institution of Civil Engineers in London (*Proceedings*, Institution of Civil Engineers, 1934). A main dam of boulder clay and sand, 20 miles long, built at a cost of $60,000,000 in the open sea from 10 to 40 ft deep, forms the salt water barrier of the Yssel Lake. This lake, previously open sea, has an area of 270,000 acres, and is to be converted into a fresh water lake. There are 25 sluices in the main dam, having openings 40 by 12 ft, and there are locks for inland navigation that are 46 by 470 ft.

I should like to quote as follows from a pamphlet entitled *The Story of the Zuyderzee Works* received through the courtesy of Mr. van Kuffeler: "The capitalized value of the Yssel Lake as a fresh water reservoir is put at well over $80,000,000. It will provide a sufficiency of good drinking water for cattle at all times, in those districts which were formerly hard put to it to provide water in times of drought." Here is a salt water barrier built for the purpose of converting open sea into a fresh water lake, and to serve as equalizing reservoir for the drainage of 550,000 acres of adjoining sea bottom. This sea bottom, which for geological ages had been thoroughly impregnated with salt, was drained in the "Northwest polder" on August 21, 1930; the first rye crop was harvested in 1931.

The canals in the Netherlands have been commonly used for sewage disposal, and the well-known Dr. Karl Imhoff uses the storage reservoirs on the river Ruhr for sewage disposal on a large scale. The success of this method naturally depends on the relative concentration, in order to avoid creating a nuisance. It does not necessarily rule out the salt water barrier which, as previously stated, is operated successfully on a very large scale.

A. STREIFF, M. Am. Soc. C.E.
Vice-President, Ambursen Dam Company

Austin, Tex.
November 25, 1935

Progress in the Use of Limestone in Building Construction

TO THE EDITOR: In his article, "Some Facts About Limestone," in the October issue, Paul V. McHenry presents a very comprehensive and interesting description of the quarrying and production for commercial use of one of the important materials used in modern bridge and building construction.

To the engineer who takes pride in the permanency and beauty of his work, it is of interest to note that limestone is as useful in the construction work of today as it was to the builders of the ancient pyramids thousands of years ago. Although it is used in a different manner structurally, it presents the same pleasing and esthetic appearance to the eye.

By its inherent physical properties of color, density, uniformity, and massiveness, limestone lends itself readily to use in large building construction. One has only to cite its wide use in the architectural treatment of not only the world's tallest building and other skyscrapers, but also the massive public buildings recently completed in the national capital and elsewhere throughout the country to illustrate its esthetic beauty and harmony in modern construction.

That oolitic limestone lends itself quite easily to ornamentation and decoration by hand tooling cannot be overemphasized. The refinement and beauty of detail, large or small, which can be produced in stone by the skilled artisan is remarkable. Indiana's World War Memorial (in Indianapolis) and other comparable structures are evidence of this fact.

In addition to the geologic history of Indiana limestone as detailed by Mr. McHenry, the terrain of Lawrence and Monroe counties is strategically located with respect to the geologic Ice Age period which, no doubt, had marked effects upon the area. Although there is no definite line of demarcation, large marginal morainic deposits and moraines lying in a zigzag line across the state from east to west are located approximately 20 to 40 miles north of this district. These represent the southernmost advance of the most recent heavy glaciation. South from these deposits, glacial drift becomes thinner and finally disappears. Although it is a matter of geologic conjecture as to the actual occurrences during the great Ice Age, which lasted thousands of years as the ice sheets advanced, retreated, and advanced again, it cannot be discounted that the subsequent glaciation—natural overburden stripping by the ice—and erosion had much to do in making this valuable deposit as accessible as it is today. This is fortunate, indeed, for the building industry which obtains over 60 per cent of its building stone from this district, as limestone deposits farther to the north are known to be covered with 400 ft of glacial drift! With perhaps a part of the pervious overlying strata stripped by glaciation, subsequent weathering, stream action, and frost through the intervening centuries have combined to make the deposits occur near the earth's surface and in the condition in which they are found today.

In conclusion, it might be of interest to record a comparison of present-day quarrying volume with one of the structures of antiquity. In 1931, one of the peak years of limestone production, Indiana alone produced approximately enough building stone to build a replica of the Mycernius, or Meukau-Ra pyramid in Egypt, the third largest of the famous Gizeh group and built about 4550 B.C. The pyramid undoubtedly required the labor of thousands of men for at least a decade for quarrying and construction, while one year's quarrying is a more or less casual occurrence to us today. Such has been man's progress in 65 centuries recorded in limestone.

LYNDON F. KIRKLEY, Jun. Am. Soc. C.E.
Junior Engineer, McClintic-Marshall Corporation

Bethlehem, Pa.
December 3, 1935

Variations in Heating Affect Asphalt Penetration Tests

TO THE EDITOR: Rigid adherence to a definite procedure in testing is essential in order that the results secured in various laboratories throughout the country may be comparable. Sometimes, however, the standard methods permit variations in details of procedure, which produce variations in the test results. These variations become important, especially in cases where a producer is furnishing a material just within the limits of the specifications. The producer may test it in such a way that it qualifies, while the user may vary the procedure enough to cause rejection, even though both apparently qualify as to method.

The test for residue at specified penetration (D 243 32T of the American Society for Testing Materials) is one which may produce variations in results, due to differences in the intensity of the heat applied during the interval when the temperature of the liquid asphalt is between that of air and 249 to 260 C. In this test a 100-g sample of liquid asphalt is heated between 249 and 260 C, until the residue gives a desired penetration when tested at 25 C for 5 sec under a load of 100 g. If the residue is too soft, the sample may be heated further and additional penetration tests made. No time limit is placed on the intervals during which the sample is being raised to the temperature 249 to 260 C, nor for the cooling period following the heating.

This test is done as part of the regular work in a course in highway materials, required of third-year students in civil engineering at the University of Illinois. Each squad is assigned a definite percentage of residue, and after all the tests are made a graph is drawn with the percentage of residue plotted against the penetration. In order to assign percentages of residue which can be used in plotting the graph, it is necessary to know the answer ahead of the beginning of the student work.

In making the preliminary determination last year, an electric heater was used which took about 40 min to bring the sample to the proper temperature. The students, however, used bunsen burners which are capable of raising the sample to 250 C in less than 10 min. When the penetration tests were made on the student samples, the residues were all too soft, the needle penetrating the entire sample.

In the search for the cause of the different results, it was remembered that a number of years previously a material had changed consistency without losing weight in this same test. The test was repeated, using different rates of increasing the temperature initially and following each cooling for weighing. The samples were heated until the residues had approximately the same weight. The results, which are shown in the accompanying tabulation, indicate a relationship between the rate of attaining the heating temperature of 249 to 260 C and the penetration of the residue for the same percentage of residue.

Reference Number	Time Required for Attaining Range of 249 to 260 C in Min	Percentage of Residue	Penetration 100 G, 5 Sec, 25 C
1	less than 10	64	96
2	20	64	70
3	40	65	50

Results obtained by students this fall indicate the same effect. Preliminary determinations were made by the use of gas heat, and the samples were brought to the heating range in less than 10 min. The students who were assigned the lower percentages of residue found penetration values lower than those given by the curve established from the preliminary tests. These students weighed their samples more times than the others, and during the periods of cooling and reheating the consistency of the asphaltic residue was changing.

These tests indicate a need for a time limit to be placed on the intervals during which the temperature of the sample is being raised or lowered. They are also a reminder to the men in the field that the consistency of bituminous materials changes during periods of heating, especially those of long duration and high temperatures.

Edward E. Bauer, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering
University of Illinois

Urbana, Ill.
November 27, 1935

Low-Heat Cement at Morris Dam

To the Editor: In his article, "Construction of Morris Dam," in the September number, Verne L. Peugh, Assoc. M. Am. Soc. C.E., has covered in a comprehensive manner the modern construction methods employed.

So far as I know, this is the first dam where low-heat cement was used for reducing internal stresses in the dam. Tests conducted on local brands of cement gave heats of hydration varying from 90 to 110 calories per gram in 28 days. The specifications for the purchase of portland cement as finally modified provided that it conform to the standard specifications of the American Society for Testing Materials with the following exceptions:

1. The percentage of tricalcium aluminate by weight should not be less than 1 per cent or more than 6 per cent.

2. The residue on a standard 200-mesh sieve should not be more than 8 per cent or less than 2 per cent by weight.

3. No requirement was placed upon the tensile strength of standard mortar briquettes.

4. The compressive strength for 2 by 4-in. cylinders made of 1:3 cement and Ottawa sand should not be less than 800 lb per sq in. for 7 days and 2,000 lb per sq in. at 28 days, with the further requirement that the 28-day tests should show strengths at least 30 per cent greater than for the 7-day tests.

5. The heat of hydration of cement should not exceed 65 calories per gram at 7 days or 80 calories per gram at 28 days.

This low-heat cement was supplied from four local mills, and the results of the laboratory tests show that the heat of hydration on the average was approximately 55 calories per gram at 7 days and 65 calories per gram at 28 days. Compressive strengths for 2 by 4-in. cylinders at 7 days ranged from 1,200 to 1,800 lb per sq in. and from 3,000 to 4,000 lb per sq in. at 28 days.

A modern field laboratory including a 600,000-lb testing machine was located at the dam. In addition, a well-equipped chemical laboratory, provided with a very accurate, specially built calorimeter for determining the heat of hydration, was maintained at Pasadena for checking chemical analyses. Chemical and heat-of-hydration tests were made for each 1,000 bbl of cement, and physical tests in the field laboratory for each 250 bbl.

The contract provided that the dam be ready to store water 20 months from date of contract. The following unusual features added to the difficulties of construction.

1. The main highway, which serves numerous resorts in addition to two rock-fill dams under construction by the Los Angeles County Flood Control District in the upper watershed, passed through the lower part of the dam site. The permit granted to the city by the U. S. Forestry Service required that this road be maintained until the new highway on the west side of the canyon above maximum high water was completed under a separate contract. This provision prevented the contractors from completing the trash rack under the flood release outlets and closing the gap left in block No. 6 used for by-passing the highway travel from November 1932 to July 1933.

2. Approximately 15 ft below the crest of the dam on the east abutment an old power conduit was constructed along the face of the mountain. It was necessary for the contractor to by-pass this conduit during construction by driving a tunnel around the abutment.

3. On account of the high value of reservoir storage in this section the contract provided that by paying 20 cents per cu yd the contractor might place 200,000 cu yd of excavated material in the reservoir area above the dam. The remaining yardage from the spillway, the west abutment lining, the cut-off trenches, and the upper and lower parts of the dam were hauled by truck some distance below the dam and largely deposited on the steep west slopes of the canyon so as not to interfere with stream flow.

4. Progress on abutment foundations and cut-off trenches was slow on account of the large amount of hand work required and special treatment necessary along fault lines.

5. Specifications provided for the pouring of mass concrete in the dam in 5-ft lifts with a minimum interval between pours of 64 hr.

The contractors and the engineering staff of the city are to be complimented on the rapid progress of the work.

Kenneth Q. Volk, M. Am. Soc. C.E.
Metropolitan Water District of
Southern California

Los Angeles, Calif.
December 5, 1935

Eighty-Third Annual Meeting

New York, N.Y., January 15–18, 1936—Program of Sessions, Entertainment, and Trips

Business Meeting, Conferring of Honorary Membership, Prize Awards, and Committee Reports

WEDNESDAY—January 15, 1936—Morning

AUDITORIUM

9:00 **Registration**

10:00 **Eighty-Third Annual Meeting called to order by**

ARTHUR S. TUTTLE, *President, American Society of Civil Engineers; Consulting Engineer; New York State Engineer and Acting State Director, Federal Emergency Administration of Public Works*, New York, N.Y.

Report of the Board of Direction

Report of the Secretary

Report of the Treasurer

10:30 **Conferring of Honorary Membership**

JOHN W. ALVORD, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill. Mr. Alvord will be presented to the President by HARRISON P. EDDY, *Past-President, Am. Soc. C.E., Consulting Engineer*, Boston, Mass.

J. F. COLEMAN, *Past-President, Am. Soc. C.E., Consulting Engineer*, New Orleans, La. Mr. Coleman will be presented to the President by E. N. NOYES, *M. Am. Soc. C.E., Consulting Civil Engineer*, Dallas, Tex.

MORTIMER E. COOLEY, *M. Am. Soc. C.E., Dean Emeritus, Colleges of Engineering and Architecture, University of Michigan; State Engineer, P.W.A.*, Detroit, Mich. Dean Cooley will be presented to the President by HENRY E. RIGGS, *Vice-President, Am. Soc. C.E., Honorary Professor, Civil Engineering, University of Michigan*, Ann Arbor, Mich.

W. J. WILGUS, *M. Am. Soc. C.E., Consulting Engineer*, Ascutney, Vt. Colonel Wilgus will be presented to the President by J. P. H. PERRY, *M. Am. Soc. C.E., Vice-President, Turner Construction Company*, New York, N.Y.

11:00 **Presentation of Society Medals and Prizes**

The Norman Medal to the late D. C. HENNY, *M. Am. Soc. C.E.*, who was *Consulting Engineer*, Portland, Ore., for Paper No. 1881, "Stability of Straight Concrete Gravity Dams."

The J. James R. Croes Medal to A. T. LARNED, *M. Am. Soc. C.E., Civil and Hydraulic Engineer, Phoenix Engineering Corporation*, New York, N.Y., and W. S. MERRILL, *M. Am. Soc. C.E., Hydraulic Engineer, Ebasco Services, Inc.*, New York, N.Y., for Paper No. 1877, "Actual Deflections and Temperatures in a Trial-Load Arch Dam."

The Thomas Fitch Rowland Prize to W. H. KIRKBRIDE, *M. Am. Soc. C.E., Chief Engineer, Southern Pacific Company, Pacific Lines and Subsidiary Lines*, San Francisco, Calif., for Paper No. 1860, "The Martinez-Benicia Bridge."

The James Laurie Prize to WILSON T. BALLARD, *M. Am. Soc. C.E., Engineer, P.W.A.*, Baltimore, Md., for Paper No. 1876, "Three-Span Continuous-Truss Railroad Bridge, Cincinnati, Ohio."

The Arthur M. Wellington Prize to HAWLEY S. SIMPSON, *M. Am. Soc. C.E., Research Engineer, American Transit Association*, New York, N.Y., for Paper No. 1880, "Use and Capacity of City Streets."

The Collingwood Prize for Juniors to C. MAXWELL STANLEY, *Jun. Am. Soc. C.E., Engineer* (*Young and Stanley, Inc.*), Muscatine, Iowa, for Paper No. 1867, "Study of Stilling-Basin Design."

The Rudolph Hering Medal to ROBERT A. ALLTON, *M. Am. Soc. C.E., Sewage Disposal Engineer, Department of Public Service*, Columbus, Ohio; ORRIS BONNEY, *M. Am. Soc. C.E., Sewerage Relief Engineer, Division of Engineering, Department of Public Service*, Columbus, Ohio; JOHN H. GREGORY, *M. Am. Soc. C.E., Consulting Engineer; Professor of Civil and Sanitary Engineering, The Johns Hopkins University*, Homewood, Baltimore, Md.; and the late R. H. SIMPSON, *M. Am. Soc. C.E.*, who was *Chief Engineer, Department of Public Service*, Columbus, Ohio, for Paper No. 1887, "Intercepting Sewers and Storm Stand-by Tanks at Columbus, Ohio."

11:15 **Presentation of Reports of Committees**

COMMITTEE ON EARTHS AND FOUNDATIONS

LAZARUS WHITE, *M. Am. Soc. C.E., President, Spencer, White and Prentis, Inc.*, New York, N.Y., *Chairman.*

COMMITTEE ON FLOOD PROTECTION DATA

GERARD H. MATTHES, *M. Am. Soc. C.E., Principal Engineer, Office of President, Mississippi River Commission*, Vicksburg, Miss., *Chairman.*

COMMITTEE ON SALARIES

E. P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y., *Chairman.*

12:00 **New Business**

Report of Tellers on Canvass of Ballot for Officers

Introduction of President-Elect and New Officers

12:30 **Luncheon**

Fifth floor, Engineering Societies Building. Tickets $1.00 each.

Use Railroad Certificate to Obtain Reduced Fare. Consult Your Ticket Agent for Selling Date in Your Territory.

General Session—President's and Honorary Members' Dinner, Reception, and Dance

WEDNESDAY—January 15, 1936

Afternoon

GENERAL MEETING

AUDITORIUM

Arranged Under Auspices of
Engineering-Economics and Finance Division

2:30 **Report of Committee on Principles to Control Governmental Expenditures for Public Works**

FRED LAVIS, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

Discussion opened by

CHARLES KELLER, *M. Am. Soc. C.E., Brigadier-General, U.S.A. (Retired), Consulting Engineer*, Chicago, Ill., *Chairman, Committee on Principles to Control Governmental Expenditures for Public Works.*

Division Business Session

Annual Report of Chairman
Committee Reports
New Business

Evening

DINNER DANCE

HOTEL ROOSEVELT

Committee: C. W. BRYAN, JR., *Chairman;* WILLIAM MCK. GRIFFIN, E. DEV. TOMPKINS, AND A. D. HUNTER

7:00 **Assembly**

7:30 **Dinner**

9:30 **Reception to the President and Honorary Members**

10:00 **Dancing**

This function will be held at the Hotel Roosevelt, Madison Avenue and 45th Street, the Grand Ballroom to open at 7:00 p.m., and the dinner to be served promptly at 7:30 p.m.

Arrangements have been made for tables seating ten persons, and members may underwrite complete tables Orders to underwrite a table must be accompanied by check in full and a list of guests.

Tickets will be $5.00 each. Tickets for Juniors, for the dance only, will be $2.00 per couple.

The seating for the dinner dance list will close at 5:00 p.m., Tuesday, January 14, 1936. Those who purchase tickets after that hour will be assigned to tables in the order of their purchase. Tickets will be on sale at Society Headquarters until 5:00 p.m., Wednesday, January 15, 1936.

Sessions of Technical Divisions Occupy Entire Day

THURSDAY—January 16, 1936—Morning

CONSTRUCTION DIVISION

Symposium on
Advances in Construction Equipment and Methods

10:00 **Introduction**

A. J. ACKERMAN, *Assoc. M. Am. Soc. C.E., Construction Plant Engineer, Tennessee Valley Authority*, Knoxville, Tenn.

10:20 **Earth Moving**

T. T. KNAPPEN, *Assoc. M. Am. Soc. C.E., Chief, Engineering Division, U. S. Engineer Office*, Zanesville, Ohio.

10:40 **Concrete Handling**

LION GARDINER, *Esq., Vice-President, Jaeger Manufacturing Company*, Columbus, Ohio.

11:00 **Welding**

WILLIAM SPRARAGEN, *Esq., Technical Secretary, American Welding Society, and Secretary, American Bureau of Welding*, New York, N.Y.

11:20 **Structural Erection Practice**

DAVID S. FINE, *Esq., Assistant Engineer, Erecting Department, American Bridge Company*, New York, N.Y.

11:40 **Discussion**

HIGHWAY DIVISION

10:00 **Recent Developments in Pavement Design**

JULIUS ADLER, *M. Am. Soc. C.E., Consulting Engineer* Philadelphia, Pa.

10:30 **Discussion**

11:00 **Highway Connections with the Triborough Bridge, New York City**

J. C. EVANS, *Esq., Engineer of Approaches, Triborough Bridge Authority*, New York, N.Y.

11:30 **Discussion**

TRIBOROUGH BRIDGE, NEW YORK, N.Y.

THURSDAY—January 16, 1936—Morning (Cont'd)

CITY PLANNING DIVISION

10:00 **Reports by Committee Chairmen**

Use and Limitations of Work Relief in the Advancement of Planning Programs

HAROLD M. LEWIS, *M. Am. Soc. C.E., Consulting Engineer; Engineer and Planning Consultant, Regional Plan Association, Inc.*, New York, N.Y.

Discussion opened by

ROBERT H. RANDALL, *M. Am. Soc. C.E., President and Chief Engineer, R. H. Randall and Company, Inc.*, Clarendon, Va.

GEORGE H. HERROLD, *M. Am. Soc. C.E., Member, State Planning Board; Managing Director and Engineer, The City Planning Board*, St. Paul, Minn.

HAROLD R. DEAN, *M. Am. Soc. C.E., Consulting Engineer*, Poughkeepsie, N.Y.

SANITARY ENGINEERING DIVISION

10:00 **The Rôle of the Sanitary Engineer in Industrial Sanitation**

CHARLES L. POOL, *Assoc. M. Am. Soc. C.E., Sanitary Engineer and Chemist, State Public Health Commission*, Providence, R.I.

10:30 **Discussion opened by**

WARREN J. SCOTT, *M. Am. Soc. C.E., Chief Engineer, State Department of Health*, Hartford, Conn.

10:50 **Permeability of Earth Dam Foundations**

STANLEY M. DORE, *Assoc. M. Am. Soc. C.E., Assistant Designing Engineer, Metropolitan District Water Supply Commission*, Boston, Mass.

11:20 **Discussion**

11:40 **Report of Committee on Water Supply Engineering**

THOMAS H. WIGGIN, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y., *Chairman.*

12:10 **Business Session**

Report of Executive Committee

Reports of Committees on:
- Chemical Treatment of Sewage
- Filtering Materials
- Technical Aspects of Refuse Disposal
- Salvage of Sewage
- Sewer Rental Laws and Procedure
- Sludge Digestion
- Water Treatment Research and Plant Design
- Advancement of Sanitary Engineering
- Papers
- Rudolph Hering Medal Award Nominations
- Sanitary Engineering Division Dinner

12:45 **Adjournment**

THURSDAY—January 16, 1936—Afternoon

CITY PLANNING DIVISION

2:30 **The Future of Land Subdivision and Its Problems**

HARLAND BARTHOLOMEW, *M. Am. Soc. C.E. (Harland Bartholomew and Associates)*, St. Louis, Mo.

Discussion opened by

HENRY WRIGHT, *Esq., Associate in Town Planning, School of Architecture, Columbia University*, New York, N.Y.

H. O. POND, *M. Am. Soc. C.E., Engineer*, Tenafly, N.J.

RUSSELL V. BLACK, *M. Am. Soc. C.E., City Planner*, New Hope, Pa.

SANITARY ENGINEERING DIVISION

2:30 **Experiences with Multiple-Stage Sludge Digestion**

A. M. RAWN, *M. Am. Soc. C.E., Assistant Chief Engineer;* A. PERRY BANTA, *Assoc. M. Am. Soc. C.E., Assistant Engineer; and* RICHARD POMEROY, *Esq., Research Chemist, Los Angeles County Sanitation Districts*, Los Angeles, Calif.

3:00 **Discussion**

3:20 **The Design of Aeration Tanks for the Activated Sludge Process**

S. W. FREESE, *Assoc. M. Am. Soc. C.E., Consulting Engineer*, Fort Worth, Tex.

3:50 **Discussion**

4:10 **The Grinding of Garbage and Its Disposal to Sewers**

C. E. KEEFER, *M. Am. Soc. C.E., Principal Assistant Engineer, Bureau of Sewers*, Baltimore, Md.

4:40 **Discussion opened by**

C. K. CALVERT, *Esq., Chemist, Indianapolis Sewerage Commission*, Indianapolis, Ind.

5:00 **Adjournment**

STRUCTURAL DIVISION

2:30 **Presentation of Reports of Division Committees**

(1) Committee on Modern Stress Theories and Fatigue Research

A. V. KARPOV, *M. Am. Soc. C.E., Designing Engineer*, Hydraulic Department, Aluminum Company of America, Pittsburgh, Pa.

(2) Committee on Structural Alloys

ROBERT S. JOHNSTON, *M. Am. Soc. C.E., Director of Research, John A. Roebling's Sons Company*, Trenton, N.J., *Chairman.*

(3) Committee on Wind Bracing in Steel Buildings

C. R. YOUNG, *M. Am. Soc. C.E., Professor of Civil Engineering, University of Toronto*, Toronto 5, Ontario, Canada, *Chairman.*

(4) Committee on Bridge Floors

SHORTRIDGE HARDESTY, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y., *Chairman.*

STUDENT CHAPTER CONFERENCE

THURSDAY—January 16, 1936—Afternoon

4:00 **A Conference of the Representatives and Members of Student Chapters**

All students, members, and others interested are invited to attend this conference, which will be held on Thursday, January 16, 1936, from 4:00 to 6:00 p.m., at Society Headquarters.

Entertainment for the Ladies—Smoker for the Men

THURSDAY—January 16, 1936

Afternoon

FASHION REVIEW AND TEA

GRAND BALLROOM, HOTEL ROOSEVELT

Committee: EMIL PRAEGER, *Chairman;* ROBERT H. JACOBS *and* J. J. KNOX

3:00 Fashion Review

The ladies will be entertained at a Fashion Review at the Hotel Roosevelt.

5:00 Tea

Following the Fashion Review, tea will be served.

8:00 Social Evening and Bridge

At the Engineering Woman's Club, Inc., 123 East 37th Street, followed by refreshments.

An evening of entertainment has been planned by the Ladies Committee at the Engineering Woman's Club for the ladies who care for cards.

There is no charge for one ticket. Additional tickets are $1.00 each.

Engineering Woman's Club

Through the courtesy of the Engineering Woman's Club, Inc., 123 East 37th Street, the facilities of the club will be available to the ladies during the entire Annual Meeting.

All ladies are especially invited to make the Club their headquarters. Members of the Ladies Committee will be at the Club to assist visiting ladies in getting acquainted and to furnish information about shopping, sightseeing, and points of interest.

There will be an information desk for ladies at Society Headquarters. All ladies are requested to avail themselves of the facilities of the Society or the Engineering Woman's Club.

Evening

SMOKER AND ENTERTAINMENT

GRAND BALLROOM, HOTEL PENNSYLVANIA

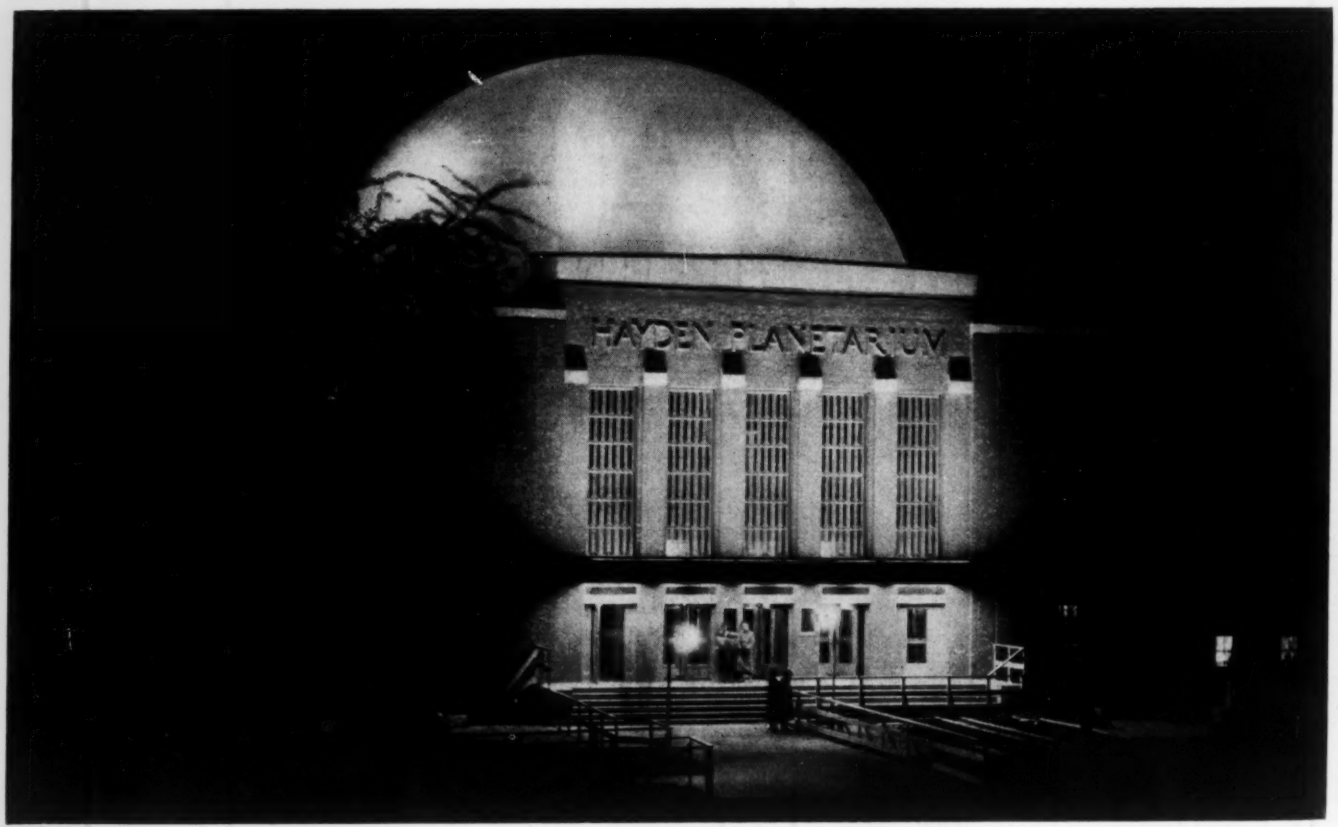
Committee: DAVID BONNER, *Chairman;* E. W. STEARNS, HERBERT W. HALE, *and* ALFRED HEDEFINE

Place—Grand Ballroom, Hotel Pennsylvania.

Time—8:00 p.m.

The Committee has arranged something different from past Smokers. There will be no speaker or lecturer. Members will have ample opportunity to meet friends and renew acquaintances. An interesting program of entertainment has also been planned. Throughout the evening there will be an orchestra to promote songs and in addition there will be some amateur and some professional entertainers and some from within our own ranks. There will be abundant refreshments and smokes and plenty of tables to seat the entire audience.

Tickets for the Smoker and evening's entertainment are free to members. Guest tickets are $2.00 each.



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HAYDEN PLANETARIUM AT THE MUSEUM OF NATURAL HISTORY

Inspection Trip Through Rockefeller Center on Friday

Radio City Music Hall or Hayden Planetarium in Afternoon

Committee: W. J. Barney, *Chairman;* S. J. Ott, Robert W. Sawyer, 3d, Orrin H. Pilkey

FRIDAY—January 17, 1936—Morning

10:30 Trips Through Rockefeller Center

Members, ladies, and guests will have the opportunity of inspecting the largest building project ever undertaken by private capital. The development occupies some 12 acres of ground space, and when finished will include 11 buildings, 9 of which are now completed.

The party will assemble at the Guided Tour Lounge in the R.C.A. Building, Sixth Avenue between 49th and 50th Streets, where guides will be assigned to groups of 20 to 25 persons.

There will be the choice of one of two trips.

(1) Trip "A," a Visit to the Mechanical and Operating Equipment of the Vast Establishment, as Follows:

The electrical power station for the N.B.C. Studios.

The steam inlet room for heating the development.

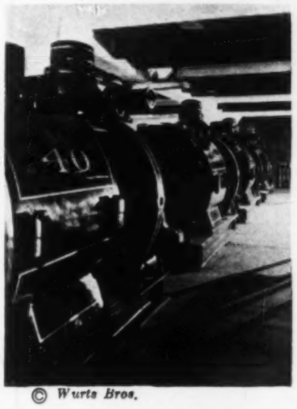
The air-conditioning machine room, which controls the ventilation of all interior shops throughout the Great Hall, the interior shops in the Great Hall, Concourse, and basement halls.

The pump rooms where the water is lifted to the various stages of reservoirs throughout the 70-story R.C.A. Building.

The truck ramp and platform level where all freight is delivered; the design of this area for ventilation and lighting is similar to that of the Holland Tunnel.

The bonded warehouse and the excavation between the Radio City Music Hall and Rockefeller Plaza; from this excavation the rock strata which is the foundation of Manhattan can be studied.

An elevator machinery room and automatic control for the world's swiftest elevators.



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Elevator Machinery Room, R.C.A. Building

The finale will be a visit to the Observation Roof and the studios of the National Broadcasting Company.

(2) Trip "B," Arranged for Those Who Prefer to See the Art and Architectural Features, as Follows:

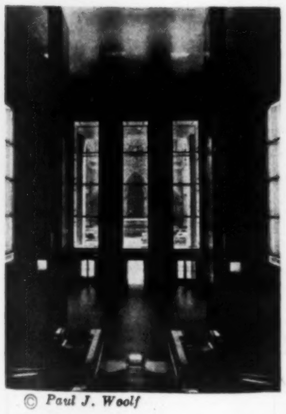
A visit through each of the nine buildings now completed in Rockefeller Center.

The art of Frank Brangwyn, José Sert, Ezra Winter, Lee Lawrie, and other famous artists will be pointed out and interpreted.

The lounge and lobby of the two theaters—the Radio City Music Hall and the Center Theater.

This trip likewise will conclude with a visit to the Observation Roof and a tour through the studios of the National Broadcasting Company.

The studio tour is a visit behind the scenes of radio in which is exhibited the method of producing sound effects, types of studios, explanation of the master control room, and many other interesting features.



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View from International Building Overlooking Fifth Avenue

FRIDAY—January 17, 1936—Afternoon

12:30 Luncheon in the R.C.A. Building

The entire party will assemble about 12:30 p.m. for luncheon in the R.C.A. Building.

Tickets for either of the trips, including luncheon, are $2.50 each.

Radio City Music Hall

2:00 Performance at Radio City Music Hall

Following luncheon, members of the party may attend the afternoon performance at the Radio City Music Hall. A block of seats has been reserved, the price of the tickets being $1.10 each.

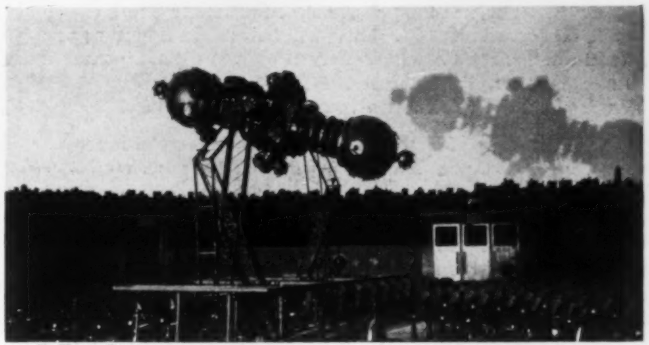
3:00 Lecture at Hayden Planetarium

For those who may prefer to attend a lecture at the recently opened Hayden Planetarium, arrangements have been made for a limited number of reserved seats for the 3:00 p.m. performance.

The planetarium may be reached via the Sixth Avenue Elevated, boarding uptown trains at the 50th Street station immediately adjacent to the Sixth Avenue entrance to the R.C.A. Building, and traveling thence to the 81st Street station.

The Hayden Planetarium is a part of, and is managed by, the American Museum of Natural History. Following the lecture in the planetarium, members of the party may take advantage of the many points of interest in the museum.

Tickets to the planetarium lecture are 50 cents each.



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View of Interior of Planetarium, Showing Projector

College Reunions Throughout the Week

Alumni Gatherings Scheduled for Visiting Engineers

WEDNESDAY—January 15, 1936

Lehigh University Alumni Dinner

A cordial invitation is extended to all Lehigh members of the Society to attend a monthly dinner of the Lehigh Club of New York, Inc., to be held at No. 2 Park Avenue (26th floor), 32d to 33d Streets, New York, N.Y., on Wednesday, January 15, 1936, at 6:30 p.m. Dinner will cost $1.75.

Please promptly notify Alexander Potter, 50 Church Street, New York, N.Y., if you can be present even for a part of the evening. Club rooms will be open for Lehigh men prior to the dinner.

THURSDAY—January 16, 1936

Dinner of Columbia Engineers

The graduates of Columbia University who are members of the Society will meet for an informal dinner on Thursday, January 16, 1936, at 6:15 p.m., at the Columbia University Club, 4 West 43d Street, New York, N.Y. Lantern slides illustrating some of the recent research work of the Department of Civil Engineering will be shown. The charge will be $1.25 per cover. Address communications to J. K. Finch, Columbia University, New York, N.Y.

Cornell Society of Engineers

On Thursday, January 16, 1936, there will be a dinner in honor of Jim Lynah, '05, our new athletic director at Ithaca. Those desiring to attend can obtain full information from The Cornell Club of New York. Out-of-town Cornellians may, upon application to the Club, receive guest cards entitling them to the privileges of the Club for the week of the Society meeting.

Lafayette College Civil Engineers' Dinner

All civil engineers of Lafayette College are invited to attend an informal dinner on Thursday, January 16, 1936, at 6:00 p.m., in the Grill Room of the Happiness Restaurant, 6 East 39th Street, New York, N.Y. If possible, come at 5:30 p.m. The charge will be $1.10 per cover. If you plan to attend, please notify William R. Wolff, 80 Centre Street, New York, N.Y.

Luncheon of M. I. T. Engineers

All M. I. T. alumni are invited to a luncheon at the Technology Club of New York, on Thursday, January 16, 1936, at 12:30 p.m., at the club rooms, 22 East 38th Street, New York, N.Y. Please notify the Technology Club (Caledonia 5-1475) as to attendance.

New York University Alumni Reunion Dinner

The New York University Civil Engineers' Alumni Dinner will be held at Rutley's Grill, 1440 Broadway, New York, N.Y., on Thursday evening, January 16, 1936. There will be a social gathering at 6:00 p.m., and dinner at 6:30 p.m. The charge will be $1.00 per cover. For reservations write Gerald A. Fleet, 2188 Creston Avenue, New York, N.Y.

University of Illinois Engineers' Dinner

All University of Illinois engineers and their friends are invited to the Eighth Annual Informal Dinner-Reunion at the Hotel Woodstock, 127 West 43d Street, New York, N.Y., on Thursday, January 16, 1936, at 5:45 p.m., in the Elizabethan Grill.

The dinner will cost $1.00 and will be over in time for guests to attend the Society's Smoker. If you plan to attend, please notify Bruce Johnston, 421 Engineering Building, Columbia University, New York, N.Y. (phone, University 4-3200, Extension 107).

University of Pennsylvania Civil Engineers' Dinner

The Seventeenth Annual Informal Dinner of the University of Pennsylvania Civil Engineers will be held at the University of Pennsylvania Club, 37 East 36th Street, New York, N.Y., on Thursday, January 16, 1936, from 6:00 to 7:30 p.m. The dinner fills in the time from the end of the Technical Session at 5:00 p.m. until the commencement of the Smoker at 8:00 p.m. Dinner will be served at 6:00 p.m. sharp, in the main dining room of the club.

The charge per cover will be $1.10. Any further information can be obtained from Albert B. Hager, Care, Atlantic Gulf and Pacific Company, 15 Park Row, New York, N.Y.

Luncheon of Chi Epsilon Honorary Civil Engineering Fraternity

Members of Chi Epsilon, their families and their friends, are again extended a cordial invitation to attend a very informal luncheon at the Midston House (Cornell Club Building), 22 East 38th Street, New York, N.Y., Thursday, January 16, 1936, at 1:15 p.m.

Those interested should file advance notice with R. I. Land, 10th Floor, 100 East 42d Street, New York, N.Y. (phone, Ashland 4-3300, Ext. 194), or H. T. Larsen, Room 1607, Engineering Societies Building, New York, N. Y. (phone, Pennsylvania 6-9220).

For the luncheon a charge of $1.00 per person will be made. It is hoped that as many Chi Epsilon members as possible, with their friends, will remember this date.

FRIDAY—January 17, 1936

Brown Engineering Association

The Brown Engineering Association will hold its Twenty-Second Annual Dinner Meeting at the Brown Club, 39th Street and Park Avenue, New York, N.Y., on Friday, January 17, 1936, at 6:30 p.m. Dr. Clarence A. Barbour, President of the University, will be the principal speaker. All Brown alumni are invited. The charge will be $1.50 per cover. Please notify the Brown Club (telephone, Caledonia 5-6200) as to attendance.

Harvard-Yale-Princeton Joint Meeting

The Princeton Engineering Association will be the hosts for the coming Harvard-Yale-Princeton Joint Engineering Meeting. A visit to the Hayden Planetarium will be the central feature of the meeting on Friday, January 17, 1936, which will be preceded by a supper to be held at the American Museum of Natural History, Columbus Avenue and 77th Street, New York, N.Y., at 7:00 p.m. All members are cordially invited.

Please notify David Bonner, President, Princeton Engineering Association, Care, Rodgers and Hagerty, Inc., 500 Fifth Avenue, New York, N.Y., regarding attendance.

Thayer Society of Engineers of Dartmouth College

The annual meeting and dinner of the Thayer Society of Engineers of Dartmouth College will be held at the Dartmouth College Club, New York, N.Y., at 6:30 p.m., Friday, January 17, 1936. Notify the Dartmouth College Club, 24 East 38th Street, New York, N.Y., as to attendance.

Union College Engineers' Dinner

The annual dinner of the Union College Engineers will be held at the Phi Gamma Delta Club, 106 West 56th Street, New York, N.Y., at 6:30 p.m., Friday, January 17, 1936. Reservations may be made through Frederick W. Newton, 11 Park Place, New York, N.Y. (phone, Barclay 7-1794).

University of Michigan

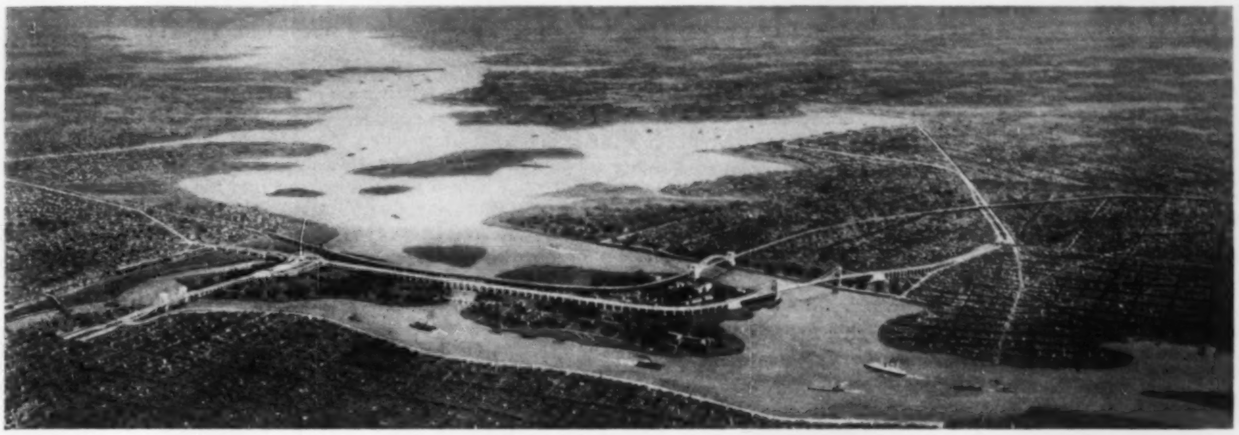
The University of Michigan Club of New York is holding its annual dinner on Friday evening, January 17, 1936, at the Hotel Pennsylvania, Seventh Avenue and 33d Street, New York, N.Y. The guest speakers will include President Alex. G. Ruthven of the University of Michigan, and the Honorable Frank Fitzgerald, Governor of the State of Michigan.

Michigan alumni who are in New York at this time are cordially invited to attend. The charge will be $3.00 per person. Reservations should be made to G. Lawton Johnson, 30 Church Street, New York, N.Y. (phone, Cortlandt 7-1350).

SATURDAY—January 18, 1936

Clarkson College Alumni Dinner

The annual dinner of the Clarkson College Alumni Association will be held at the Midston Club, 22 East 38th Street, New York, N.Y., on Saturday, January 18, 1936, at 6:30 p.m. Notify Frank C. Boes, 38 Cypress Street, Floral Park, N.Y., as to attendance.



Triborough Bridge Project

Trips to Points of Engineering Interest

SATURDAY—January 18, 1936—Morning

10:00 **Inspection Trips**

As these trips all start about the same hour, it will not be possible to participate in more than one. Members will proceed individually to the rendezvous point named for the trip selected, so as to arrive at the time given. Arrangements have been made for visits to the following points of engineering interest:

1. Triborough Bridge
2. Midtown Hudson Tunnel
3. American Museum of Natural History and Hayden Planetarium
4. Hell Gate Power Station

Triborough Bridge

Through the courtesy of the Port of New York Authority, a trip has been arranged to the construction work on the Triborough Bridge. Those going on this trip will assemble at 10:00 a.m. at the Hoyt Avenue station of the Queensborough Subway.

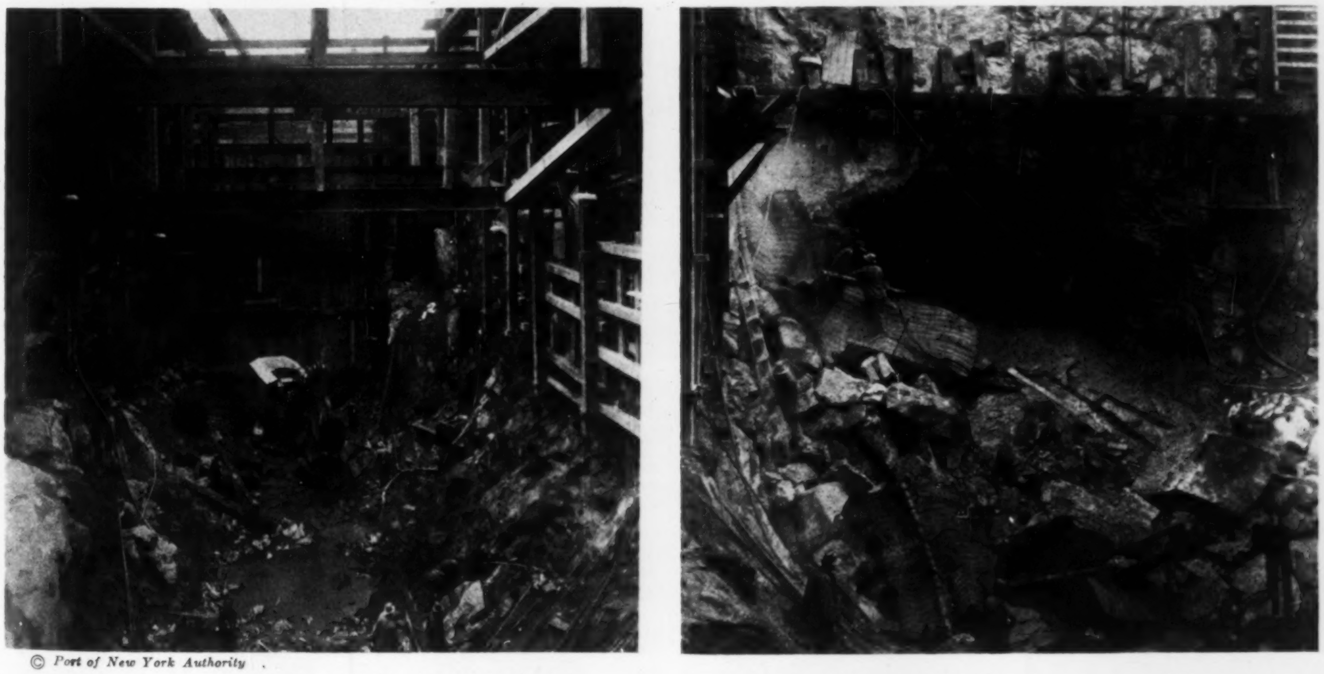
After viewing the construction in the immediate vicinity, the group will go to the East River for an inspection of the suspension bridge crossing. The party will then proceed by boat from the Tisdale Dock to the Hell Gate Bridge crossing the East River, and thence to Randall's Island, where the party will disembark and inspect the construction on the island as well as the Harlem lift-span crossing, the crossing over Bronx Kill, and the truss-span construction across the New York, New Haven and Hartford Railroad tracks. Finally, the party will be transported to the foot of East 125th Street, where local trolleys are available for the return.

Midtown Hudson Tunnel

Through the courtesy of the Port of New York Authority, arrangements have been made for a limited group to see the Midtown Hudson Tunnel, recently holed through. The tunnel is being cleaned and caulked for concreting, and concreting is in progress on the New York side.

All persons going on this inspection trip will be required to sign waivers indemnifying the contractors and the Port Authority against any damages that might result from possible accidents.

The group will assemble at the Port Authority field office on the southwest corner of 39th Street and Eleventh Avenue.



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Excavation for the New York Ventilation Building

New York Approach—Excavation for Rock Tunnel

Midtown Hudson Tunnel Construction

Saturday Trips to Museum of Natural History and the Hell Gate Power Station

American Museum of Natural History and Hayden Planetarium

Those who were unable to visit the museum or the planetarium in connection with the Friday excursion may find Saturday an opportune time.

The museum itself offers an almost inexhaustible wealth of interesting and educational exhibits. The Hayden Planetarium, a part of the museum, likewise is attracting wide public attention.

Those who wish to visit the planetarium on Saturday will find the 10:00 a.m. and the 11:00 a.m. performances convenient, the general admission charge being 25 cents.

The Hell Gate Power Station

Through the courtesy of the New York Edison Company, Inc., a visit has been arranged to the Hell Gate power station of the Company, located on the East River at 134th Street. It has a capacity of 605,000 kw, of which 105,000 kw, delivers 25-cycle current at 11,000 v and the remainder, 500,000 kw, delivers 60-cycle current at 13,800 v.

There are 26 boilers with a total steam capacity of 7,030,000 lb per hr, of which 5 have powdered fuel furnaces and 21 have mechanical stokers.

This station has high-tension tie connections with all other power plants of the New York Edison Company, Inc., and also with the Hudson Avenue station of the Brooklyn Edison Company. It also has a connection with the Upstate Niagara Hudson system, which is operated at 132,000 v. This high-tension tie connection has a capacity of 150,000 kw in either direction.

The coal is delivered by 5,000-ton steamers, and a storage of approximately 20,000 tons is maintained. The average daily consumption is 2,500 tons.

To reach this station, take the Lexington Avenue subway express to East 138th Street and then go east on the 138th Street crosstown car to the end of the line.

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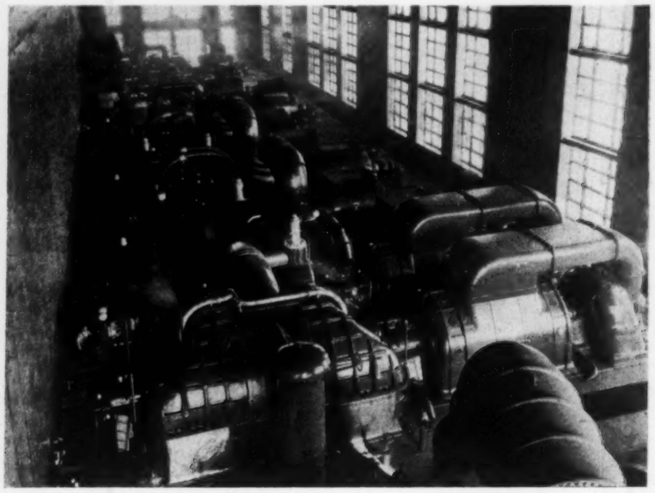
SOLAR SYSTEM ROOM, HAYDEN PLANETARIUM


HELL GATE POWER STATION

Railroad Rates, Hotel Accommodations, and General Announcements

Reduced Railroad Rates

Reduced rates on the Identification Certificate Plan have been granted by the passenger associations of the United States and the lines of the Canadian passenger associations. A certificate authorizing purchase, at starting point, of round-trip tickets at reduced rates has been mailed to the membership of the Society.

Sanitary Engineers' Dinner and Meetings

Arrangements have been made for the Annual Dinner of the Sanitary Engineering Division of the Society on Tuesday, January 14, 1936, at 7:30 p.m., at the Hotel McAlpin, Broadway and 34th Street, New York, N.Y., to which the members of the New York State Sewage Works Association have been invited. Abel Wolman, M. Am. Soc. C.E., chairman of the Water Resources Committee of the National Resources Committee, will talk on "Problems in Water Pollution Control."

Members of the Sanitary Engineering Division of the Society who may be interested, have been invited to attend the meeting of the New York State Sewage Works Association on Wednesday, January 15, 1936. Likewise members of the New York State Sewage Works Association have been invited to attend the session of the Sanitary Engineering Division on Thursday, January 16, 1936.

The charge per cover for the dinner will be $2.50. Reservations should be made not later than January 13, 1936, through James C. Harding, Mount Kisco, N.Y.

Facilities of the Engineers Club to Out-of-Town Members

For the convenience of out-of-town members, the Committee has made arrangements with the Engineers Club for luncheon and dinner on Thursday, January 16, 1936. The luncheon tickets are 85 cents each and the dinner tickets are $1.25 each; these will be on sale at the Registration Desk. The Club will also be able to accommodate a limited number of members, the price of the rooms ranging from $2.50 upward. Requests for reservations should be made in advance and addressed to Society Headquarters.

Information Desk

An Information Desk is provided in the Reading Room of the Society on the fifteenth floor of the Engineering Societies Building to assist visiting members in obtaining hotel reservations and theater tickets, and in securing any desired information about the city. Their attention is called to the facilities of the Reading Room (open until 9:00 p.m., Tuesday, Wednesday, and Thursday evenings), for meeting friends, writing letters, and receiving mail. All members are welcome to inspect and utilize the quarters of the Society.

Hotel Accommodations and General Announcements

Hotel Accommodations

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Annual Meeting, paying for the rooms in advance for at least a part of the period during which they expect to be in New York.

HOTEL RATES

Hotels	Without Private Bath		With Private Bath	
	Single Room	Double Room	Single Room	Double Room
Roosevelt	.....	.....	$3.50 up	$6.00 up
Astor	$1.50 up	$3.00 up	2.50 up	3.50 up
Commodore	.....	.....	3.00 up	4.50 up
Lexington	.....	.....	3.00 up	4.00 up
McAlpin	2.00 up	3.50 up	2.50 up	4.00 up
Murray Hill	2.00 up	3.00 up	2.50 up	3.50 up
New Yorker	.....	.....	3.50 up	5.00 up
Pennsylvania	.....	.....	3.50 up	5.00 up
Plaza	.....	.....	5.00 up	7.00 up
Savoy-Plaza	.....	.....	5.00 up	7.00 up
Taft	.....	3.00 up	2.50 up	3.50 up
Vanderbilt	.....	.....	3.00 up	5.00 up
Waldorf-Astoria	.....	.....	5.00 up	8.00 up
Woodward	.....	.....	2.50 up	3.50 up

Note: The Hotel Roosevelt, at which the reception, dinner, and dance will be held, will care for reservations to the extent of its capacity.

Special Hotel Accommodations

For the convenience of members, arrangements have been made with a number of hotels to furnish accommodations at daily rates which include breakfast, as follows:

Hotels	Single Room With Bath and Breakfast	Double Room With Bath and Breakfast (for 2)	Suite 2 Rooms with Bath and Breakfast (for 2)
Hotel Earle	$2.50	$3.50	$5.00
Hotel Holley	2.50	3.50	5.00
Hotel Van Rensselaer	2.50	3.50	5.00
Hotel Le Marquis	2.50	3.50	5.00
Hotel Wellington	3.00	4.50	6.00
Hotel Woodstock	2.75	4.50	5.50
Hotel Vanderbilt	3.75	6.50	9.50

Those interested in the above arrangement should communicate directly with Miss A. M. Fleming, 103 Waverly Place, New York, N.Y.

Introductions for Visiting Members

Members who, during their attendance at the Annual Meeting, wish introductions or meetings with engineers in New York City, may call on the Secretary's Office for any service desired.

Your New York Address

At the Registration Desk a card file of those in attendance will be maintained, with information as to members' hotel addresses in New York. Members are requested to keep Headquarters informed as far as possible of their New York addresses so as to expedite the delivery of telegrams, telephone messages, and mail.

Order All Tickets in Advance

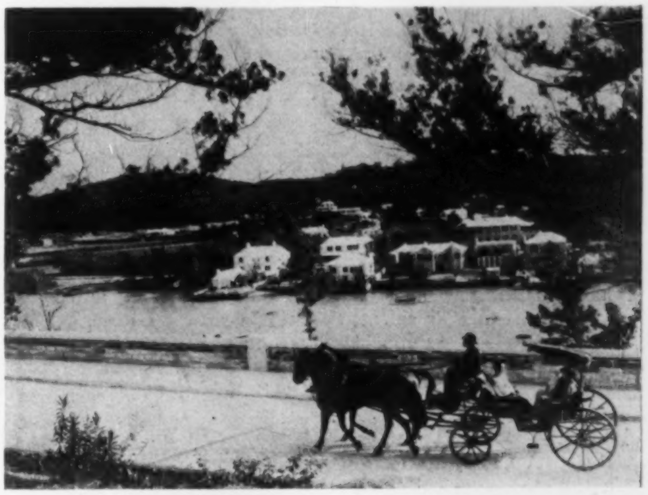
Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the Committee greatly by giving advance information to guide it in concluding arrangements. Ticket order blanks have been mailed to each member with the railroad certificate and condensed program.

No cancellation of tickets can be made after noon of Wednesday, January 15, 1936.

Bermuda in the Winter Time

The Cruise to Bermuda following the Annual Meeting last year was so successful that the trip will be repeated. This voyage is open to members and their guests at special rates on an all-expense basis. The party will leave New York on Saturday afternoon, January 18, 1936, on the *Monarch of Bermuda*, spending Sunday at sea and arriving at Hamilton early in the morning of Monday, January 20. As before, the group will stay at the Hotel Bermudiana, and the remainder of Monday and all of Tuesday will be available for sightseeing, golf, and other diversions. The group will leave Hamilton by train on Wednesday morning, January 22, for St. George, and following luncheon at the Hotel St. George, the voyagers will board the *Monarch of Bermuda* for the return, arriving in New York on Friday morning, January 24.

A special, all-inclusive price has been arranged for the whole trip, which includes round-trip transportation, stateroom with private bath, all meals on shipboard, room with private bath and all meals at the Hotel Bermudiana, the U. S. Government tax, rail transportation from Hamilton to St. George, luncheon at the Hotel St. George, and tender transfer to the *Monarch of Bermuda*. Those interested in this cruise should write to the Secretary of the Society promptly in order to be assured of accommodations.



Typical Scene in Bermuda

Committee on Local Arrangements for the Annual Meeting

E. R. Needles, *Chairman*
David Bonner, *Vice-Chairman*

W. J. Barney
C. W. Bryan, Jr.
William McK. Griffin
Herbert M. Hale
Robert H. Jacobs
S. J. Ott
Emil Praeger
Robert W. Sawyer, 3d
E. W. Stearns
E. DeV. Tompkins

Junior Members

Alfred Hedefine
A. D. Hunter
J. J. Knox
Orrin H. Pilkey

Ladies Committee

Mrs. Daniel W. Mead, *Honorary Chairman*
Mrs. Emil Praeger, *Chairman*
Mrs. William McK. Griffin, *Vice-Chairman*

Mrs. O. H. Ammann
Mrs. W. J. Barney
Mrs. David Bonner
Mrs. C. W. Bryan, Jr.
Mrs. J. K. Finch
Mrs. Herbert M. Hale
Mrs. John P. Hogan
Mrs. Leslie G. Holleran
Mrs. Otis E. Hovey
Mrs. Robert H. Jacobs
Mrs. George L. Lucas
Mrs. Edward P. Lupfer
Mrs. Thaddeus Merriman
Mrs. S. J. Ott
Mrs. J. P. H. Perry
Mrs. Carlton S. Proctor
Mrs. Robert Ridgway
Mrs. Ralph R. Rumery
Mrs. Robert W. Sawyer, 3d
Mrs. George T. Seabury
Mrs. William J. Shea
Mrs. Ole Singstad
Mrs. E. W. Stearns
Mrs. E. DeV. Tompkins
Mrs. Charles E. Trout
Mrs. Arthur S. Tuttle
Mrs. E. R. Needles

Please call on the Committee on Local Arrangements or on the Secretary's Office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Prizes and Medals to Be Presented at Annual Meeting

In accordance with its annual custom, the Society will present prizes and medals at its Annual Meeting, to be held in New York, N.Y., January 15–18, 1936. Of these the oldest Society prize is the Norman Medal, which was endowed in 1872 by the late George H. Norman, M. Am. Soc. C.E., for an original paper that is considered an especially notable contribution to engineering science. Next in distinction is the J. James R. Croes Medal, established by the Society in 1912 and named for the first recipient of the Norman Medal. This award is made for the paper considered second in merit to that receiving the Norman Medal.

The paper, which best describes in detail some accomplished works of construction, is awarded a prize established in 1882 by the late Thomas Fitch Rowland, Hon. M. Am. Soc. C.E., and bearing his name. In 1912 a prize was established by the Society and named in honor of its first President, the late James M. Laurie, M. Am. Soc. C.E., for the paper considered second in merit to that awarded the Thomas Fitch Rowland Prize. The Rudolph Hering Medal, which was instituted and endowed in 1924 by the Sanitary Engineering Division of the Society, goes to the author of the paper adjudged to contain the most valuable contribution to the advancement of the sanitary branch of the engineering profession.

In 1921 the *Engineering News-Record* established and endowed the Arthur M. Wellington Prize for the best paper on some phase of transportation. Although it is not required that the recipient of this prize be a member of the Society, its award rests with the Society. The Collingwood Prize for Juniors was established in 1894 by the late Francis Collingwood, M. Am. Soc. C.E., on his retirement as Secretary of the Society. Papers eligible for this prize must describe an engineering work or record an important investigation with which the writer has been connected. Excellence of style is a factor in the selection of the paper receiving the prize.

Robert A. Allton, M. Am. Soc. C.E., graduated from the Massachusetts Institute of Technology in 1913, with a bachelor's degree in sanitary engineering. After a short engagement with the New York State Department of Health, he entered the employ of Pearse and Greeley (now Greeley and Hansen), where he served as assistant and principal assistant engineer until 1920. For two years he was assistant to the president with Frank D. Chase, Inc., and in 1923 went to Akron, Ohio, as designing engineer for a 33-mgd sewage treatment works. Since 1928 he has been sewage disposal engineer with the City of Columbus, Ohio, and in this capacity has had charge of the design and construction of the storm standby tanks and the new 50-mgd sewage treatment works. During the War he served as captain and major of field artillery.

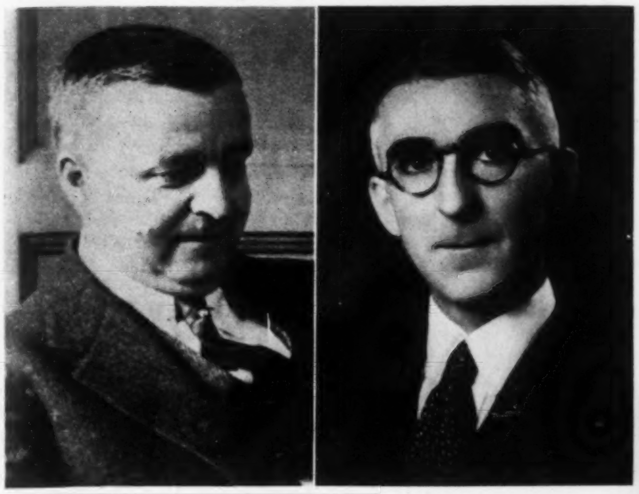
Wilson T. Ballard, M. Am. Soc. C.E., was graduated from Cornell University in 1916, with the degree of civil engineer. In May 1917, after eight months in the employ of David Lupton Sons Company of Philadelphia, Pa., he entered the First Officers' Training Camp, Ft. Myer, Va., and later was assigned to the 305th Regiment of Engineers, 80th Division, Camp Lee, Va. He was with the regiment as second and, later, as first lieutenant, his service including one year with the A.E.F. in France, until his discharge in June 1919. From November 1919 until December 1920, he was employed by Stone and Webster, Inc., as resident engineer, on building construction at Bridgeport, Conn., and Passaic, N.J. From January 1921 until October 31, 1932, he served as assistant to the chief engineer of the Paving Commission of Baltimore City in charge of street and road construction. From November 1, 1922, to July 1, 1926, he was employed by investment bankers for making investigations and reports in connection with the financing of public utility, railroad, and industrial properties. On July 1, 1926, he became an associate of the J. E. Greiner Company, consulting engineers of Baltimore, Md., and was elected vice-president of the company January 1, 1928, serving in this capacity until September 1, 1933. Since that time, he has served as engineer for the Public Works Administration of Maryland, and recently his activities were extended to include Delaware. He was vice-president of the Maryland Section of the Society during 1931, and president during 1932. He was general chairman of the Emergency Relief Committee for Technical Societies of Maryland in 1932.

Orris Bonney, M. Am. Soc. C.E., was graduated from the University of Michigan in 1918, served in the Sanitary Corps of the U. S. Army, and in March 1919 entered the employ of the City of Detroit, Mich., as a draftsman in the city engineer's office. As a draftsman and later as senior assistant engineer, he was engaged upon the design of important sewerage works in Detroit. In May 1923 he resigned to enter the employ of the Division of Engineering and Construction, City of Columbus, Ohio, where he has served successively as engineer in charge of sewers, engineer in charge of sewerage relief, and as sewerage relief engineer in which latter capacity he is now employed. In Columbus, under the general supervision of the chief engineer, Division of Engineering and Construction, he has had charge of the design and construction of sewerage works involving an aggregate expenditure of approximately $11,000,000, including a $6,000,000 PWA program now nearing completion. He has been a member of the Society since 1924 and has been active in Local Section affairs, serving as president of the Central Ohio Section from 1929 to 1930.

John H. Gregory, M. Am. Soc. C.E., was born August 7, 1874, in Cambridge, Mass., and graduated from the Massachusetts Institute of Technology in 1895, with the degree of bachelor of science in civil engineering. Ever since graduation he has been actively engaged in the design and construction of sanitary engineering works, especially water supply, water purification, sewerage, and sewage disposal works in Boston, New York, Albany, Philadelphia, Columbus, Chicago, Detroit, Toronto, Montreal, Baltimore, Washington, D.C., and other cities. From 1911 to 1917 he was a member of the firm of Rudolph Hering and John H. Gregory, consulting engineers, New York, and since 1919, in addition to his consulting practice, he has been a member of the faculty of the Engineering School of The Johns Hopkins University. In 1920 he was appointed professor of civil and sanitary engineering there. In 1932 he was appointed one of the members of the Engineers' Advisory Board of the Reconstruction Finance Corporation and so served for over a year. In 1910 he was awarded the Thomas Fitch Rowland Prize for his paper entitled "The Improved Water and Sewage Works of Columbus, Ohio," and in 1930, in conjunction with C. B. Hoover and C. B. Cornell, was awarded the James Laurie Prize for their paper entitled "The O'Shaughnessy Dam and Reservoir." He is a member of many national and local engineering societies and associations, is a former president of the Maryland Section of the Society, and served as a director of the Society for the years, 1932–1934.

D. C. Henny, late M. Am. Soc. C.E., was born in Arnhem, Holland, on November 15, 1860. He received his education at the Holland Polytechnic Institute of Civil Engineers, in Delft, where he graduated in 1881. After three years of railroad, drainage, and bridge work in Holland he came to the United States, where he engaged in railroad, water works, bridge, and tunnel construction work. In 1892 he became manager of the Excelsior Wooden Pipe Company, in San Francisco, at the same time carrying on a consulting practice, and in 1902 he took over the general managership of the Redwood Manufacturers Company. Entering the U. S. Reclamation Service in 1905 as supervising engineer of the Pacific Coast Division, he had charge of the Okanogan, Sunnyside, Tieton, Umatilla, Klamath, and Newlands projects. In 1910 he was appointed consulting engineer to the U. S. Bureau of Reclamation. He advised on many projects, among them being the Boulder

Prizes Awarded for 1935



A. T. LARNED W. S. MERRILL

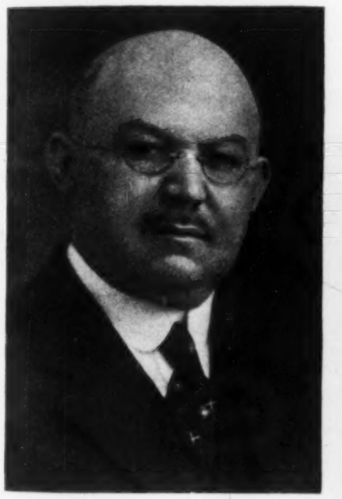
J. James R. Croes Medal for Paper, "Actual Deflections and Temperatures in a Trial-Load Arch Dam"

THE LATE D. C. HENNY

Norman Medal for Paper, "Stability of Straight Concrete Gravity Dams"

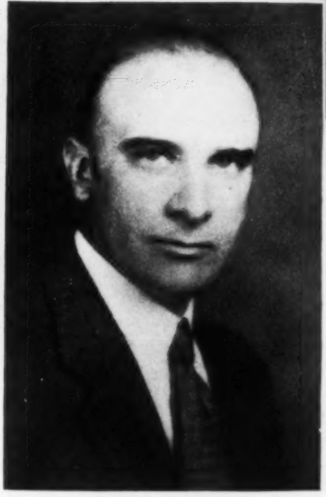
C. MAXWELL STANLEY

Collingwood Prize for Juniors for Paper, "Study of Stilling-Basin Design"



W. H. KIRKBRIDE

Thomas Fitch Rowland Prize for Paper, "The Martinez-Benicia Bridge"



WILSON T. BALLARD

James Laurie Prize for Paper, "Three-Span Continuous-Truss Railroad Bridge, Cincinnati, Ohio."

HAWLEY S. SIMPSON

Arthur M. Wellington Prize for Paper, "Use and Capacity of City Streets"

ORRIS BONNEY THE LATE ROBERT H. SIMPSON ROBERT A. ALLTON JOHN H. GREGORY

Rudolph Hering Medal for Paper, "Intercepting Storm Sewers and Stand-By Tanks at Columbus, Ohio"

Dam. Mr. Henny also maintained a consulting office in Portland, Ore., on irrigation, water power, flood control, and valuation work. Devoting generously of his time to the work of technical societies, he was successively president of the Technical Society of the Pacific Coast, of the Oregon Society of Engineers, and of the Oregon Technical Council. He was a member of the Society from 1887 until his death, which occurred on July 14, 1935. From 1920 to 1922 he served on the Board of Direction of the Society as Director. In 1932 and 1933 he was a Vice-President of the Society. He served on the Society's Committee on Arch Dam Investigation and on the Committee on High Dams, and was chairman of the Committee on Irrigation Hydraulics. He was also a member of the Royal Institute of Engineers of Holland.

WALTER H. KIRKBRIDE, M. Am. Soc. C.E., graduated from Leland Stanford University in 1895, with a civil engineering degree. After three years of private practice in civil and mining engineering in California, he became assistant chief engineer of the Sierra Railway of California. In 1902 he became associated with the Southern Pacific Company in the capacity of assistant engineer. From then until 1909 he held various positions with the Sacramento Division of this railroad. In April 1909 he was transferred to San Francisco to the position of division engineer of the Coast Division. In March 1911 he was transferred to a similar position in the Sacramento Division, and in August 1918 was made assistant superintendent of the same division. During the War, when the U. S. Government took over the railroads, Mr. Kirkbride was made chief engineer of the Pacific Lines of the Southern Pacific, in charge of some 10,434 track miles in seven Western states. When the government relinquished operating control of the railroads, he was appointed engineer, maintenance of way and structures, of the Pacific Lines, which position he held until April 1932 when he was appointed chief engineer. He was likewise made chief engineer of some of the subsidiary lines of the Southern Pacific Company. His varied duties and experience have made him conversant with general engineering problems of the West, including flood control, the construction and maintenance of timber and concrete snow sheds, tunnel enlargement and construction, the construction of rock and earth-fill dams, and bridge, viaduct, and trestle maintenance. He is a member and former director of the American Railway Engineering Association and a member of the rail committee of this association; a member and former president of the San Francisco Section of the Society; a member and vice-president of the Seismological Society of America; a member of the American Wood Preservers' Association; and president of the Pacific Railway Club.

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ARTHUR T. LARNED, M. Am. Soc. C.E., was graduated from the Worcester Polytechnic Institute in 1912, with the degree of B.S. in civil engineering. During his college career he held several engineering positions. In June 1912—after his graduation—he joined the engineering staff of the Electric Bond and Share Company of New York, with which he has been identified continuously since that date. He has been engaged in the design of hydro-electric generating stations, transmission lines, foundations for diesel electric stations, gas holder foundations, and other types of heavy structures required in the utility industry. He has been especially identified with the design and construction of 49 hydro-electric stations of all types having a total installed capacity of 669,650 kw. He has also been identified with the design and responsibility for service of the heavy foundations and condensing water facilities for 17 steam electric stations having an installed capacity of 564,000 kw. In addition to the design of generating stations and other miscellaneous structures for various utilities, he has also made office and field studies of extensions to existing power systems to meet growing load demands and has analyzed the possibilities of numerous potential hydro-electric developments in the United States, and in Central and South America. At the present time, he is civil and hydraulic engineer of the Phoenix Engineering Corporation, which renders engineering services to client companies of the Electric Bond and Share Company.

WALTER S. MERRILL, M. Am. Soc. C.E., was graduated from the University of Maine in 1910, with the degree of B.S. in civil engineering. He has also done postgraduate work in engineering and geology at Columbia, Cornell, and New York universities. Following graduation, he was employed until April 1911 by the Maine Central Railroad. He then went to Montana for three years where he was employed on irrigation investigations, surveys, and construction by the U. S. Bureau of Reclamation and Ford, Bacon and Davis. From May to September 1914, he was on bridge construction with the Boston and Albany Railroad, following which he was instructor in civil engineering at Rhode Island State College until June 1916. For the next six months he was a concrete designer on industrial and war plants for Westinghouse, Church Kerr and Company of New York City. Since January 1, 1917, he has been with the Electric Bond and Share Company of New York City as designer and hydraulic engineer. In this connection he has been intimately connected with the large power development program carried out by the Electric Bond and Share Company for its many client companies. He has had charge of the design of many important hydro-electric developments in this country and in Central and South America. In addition, he is a lecturer in the graduate school of the Polytechnic Institute of Brooklyn.

HAWLEY S. SIMPSON, M. Am. Soc. C.E., was graduated from the University of Michigan in 1922, with the degree of B.S. in C.E. Both prior to and immediately after graduation, he was employed by the Michigan State Highway Department in the survey and construction of state highways. From 1923 to 1925 he was in charge of the municipal engineering department of Verner, Wilhelm, and Molby, consulting engineers, of Detroit, Mich. During the next two years he was traffic engineer for the city of Detroit, during which time he supervised the first comprehensive traffic survey in that city. From 1927 to 1929 he was engaged as traffic engineer of the County of Essex, with headquarters in Newark, N.J. Since 1929 he has been employed by the American Transit Association as research engineer, specializing in transportation and traffic work. He has written numerous articles on street traffic and has been a member of the traffic committees of various national organizations interested in that subject, including the Highway Research Board, the National Conference on Street and Highway Safety, the National Safety Council, and the Institute of Traffic Engineers, serving as secretary of the latter organization from 1930 to 1935.

ROBERT H. SIMPSON, late M. Am. Soc. C.E., studied at Bucknell and Cornell universities, graduating from the latter in 1896, with the degree of civil engineer. For the next eight years he was with the Cleveland, Cincinnati, Chicago, and St. Louis Railway Company, passing through various grades of promotion. In June 1904, he secured a position in the Engineering Department of the Board of Public Service of the City of Columbus. In April 1906, he was transferred from this work and made engineer in charge of the city's interests in connection with the design and construction of grade-crossing elimination projects. In January 1917 he was placed in charge of the preparation of plans and supervision of construction of the Scioto River channel improvement. He was appointed chief engineer of the Division of Engineering and Construction of the Department of Public Service of Columbus in 1920, retaining this position until his death, which occurred on May 18, 1933. During this period he was in charge of many important municipal engineering activities, including the development of an extensive sewerage and sewage disposal program and the building of a municipal airport. Mr. Simpson was elected a member of the Society in 1927 and served as president of the Section for the term, 1928–1929. He was a member of the American Society of Municipal Engineers, the City Officials Division of the American Road Builders Association (of which he was vice-president for the Central District), and the Metropolitan Columbus Commission.

C. Maxwell Stanley, Jun. Am. Soc. C.E., was graduated from the University of Iowa in 1926, with the degree of bachelor of science in general engineering. Following his graduation, he accepted a position with the Byllesby Engineering and Management Corporation, where he remained for a year. From May 1927 to June 1928, he was employed on design and construction work at the Hydraulic Laboratory of the University of Iowa and, at the same time, did graduate work at the university, receiving the master's degree in hydraulic engineering in 1930. From 1928 to 1932 he was with the Management and Engineering Corporation in connection with design and construction of hydro-electric and Diesel power plants and other projects. Since 1932, he has been a partner in the firm of Young and Stanley, of Muscatine, Iowa, consulting engineers on municipal and hydraulic work. He was awarded the Alfred Nobel Prize in January 1934.

New Elections to Honorary Membership

John Watson Alvord

Someone with a flair for statistics has tried to prove that far more than the normal number of great men proportionately have been sons of clergymen. The data do not disclose whether this happy outcome is the result of normal expected development; or whether it is instead the far from natural triumph of mind over matter.

Whatever the explanation, the fact remains that John W. Alvord is the son of a New England Congregational minister and that he has attained unusual success, whether measured in terms of his engineering accomplishments or the plaudits he has received from his fellow men. He was born in 1861 and educated at private schools in Washington, D.C., preparing for a college education. But the depression following the panic of 1873 defeated this fond hope and instead he spent a year in a law office in New York City and still another year in railroad work in Colorado. He then entered the sanitary engineering field—this was to form his life work—starting in Chicago. His first job included a sewer system and work on a tunnel extending a mile under Lake Michigan.

John W. Alvord

Beginning in 1884, when he was only twenty-three years of age, and for four years thereafter, he served as city engineer of Lakeview (now Chicago), remodeling and extending water works, installing sewers, devising improved forms of lake outlets, and wrestling, for the first time, with the difficult problems of lake shore protection. Thus it was that he became interested in the study of sanitation, then a comparatively new field of engineering. He spent most of the year 1888 in Europe, where he met prominent engineers, studied sewage treatment works, and collected data on water purification. Another term of service for Cicero, Ill., a suburb of Chicago, and he was made chief of one of the engineering departments of the World Columbian Exposition, superintending the engineering work of the fair ground.

Again a depression—this time that of 1893—interrupted his plans. But he put his time to good use, studying water analysis and bacteriology and supplementing his studies by a second trip to Europe. With these activities as a background, he opened consulting offices in Chicago, which for the past forty years have continuously engaged his best efforts. A list of his works in this period, covering services for 350 municipalities in 38 states, would include the important sanitary, flood relief, and valuation efforts during this era of active development.

In 1907 a consulting engagement for the National Cash Register Company of Dayton, Ohio, gave him the opportunity to make a report, predicting the probable overtopping of the levees around the city, a prediction which went unheeded until the disastrous flood of 1913. After this confirmation of his judgment, he became one of the board of engineers to devise and report upon means of flood protection for the Miami valley and Columbus, Ohio.

Since 1902, when he was engaged on the Dubuque Water Works appraisal, he has been a keen student of valuation. His work in this field covering 200 cases soon led his ideas away from the reproduction and price-fixing theory into a more fundamental concept of value as the estimation of a coming possibility rather than past history. In several cases the U. S. Supreme Court adopted his view of "the present worth of future usefulness."

His public services have been numerous and important. During the World War he was chief engineer of the Industrial Housing Bureau, Department of Labor, in charge of some one hundred housing developments connected with the manufacture of munitions. In Chicago also his public services have been in great demand. He has served on numerous boards and commissions, including the Chicago Citizens' Terminal Plan Commission, a commission to investigate city expenditures, the Citizens' Tax Commission, the River and Harbor Committees of the Chicago Real Estate Board and the Association of Commerce, and the Illinois State Board of Natural Resources and Conservation.

In many ways he has tried to serve the profession which means so much to him. He is the author of various reports and technical papers. For one of these he received the Chanute medal of the Western Society of Engineers. In 1915 he founded and endowed the Washington Award, designed to perpetuate the recognition of engineers for "notable contributions to the public good," rather than for high technical efficiency. He has been a member and officer of various technical and engineering societies, both in America and abroad. Such services have included the presidency of the Illinois Society of Engineers, of the Western Society of Engineers, and of the American Water Works Association. From 1917 to 1921 he was Director of the Society, and in 1926 he received the Washington Award for his researches in the theory of valuation and contributions to sanitary science.

Rather drily, Mr. Alvord is wont to remark that he does not recall any notable triumph over the "forces of nature" in his long professional life; but he has experienced notable difficulty at times in overcoming the obstinacy of man. And yet he regards himself as deeply indebted to the wise minds and keen vision of the men with whom he has been so fortunate as to be associated. Every undertaking seemed to show him how to do the next thing of its kind better; and if the climb to these better things has been slow and toilsome, at least it has been safe and cautious. Always, he remarks, there have been "good friends to help along."

Most of all, Mr. Alvord has helped himself. Without formal college engineering training, he is nevertheless a highly educated, well-traveled engineer, versed in the intimate knowledge of his work far beyond the ordinary man. His exceptional facility in expressing his views may be inherited, but certainly it has been stimulated and perfected by his wide reading from the best sources.

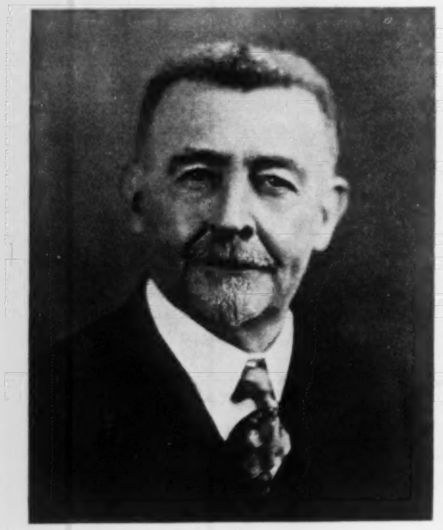
Those who know Mr. Alvord intimately recognize in him a certain gentleness in his personal relations and, at the same time, a rigidness or inflexibility where circumstances demand. His sense of proportion is keenly developed, and he is quick to appreciate the humorous side of life. He once said that the only time he had seen his name engraved on a tablet was on the cornerstone of a septic tank. Nor is he averse to the study of more simple engineering processes, as witness a well-known paper he once wrote for the Illinois Society of Engineers on the theory and practice of driving stakes. He has always claimed that this paper was the cause of more comments and notice than anything else he ever wrote.

To such a man as John W. Alvord the award of Honorary Membership is a crowning symbol—an acknowledgment of exemplary character and lovable personality, of progress to the peak of the profession by industry and self education, and of a lifetime of service to his profession.

JOHN FRANCIS COLEMAN

ON May 8, 1925, a party of distinguished engineers set out from Memphis, Tenn., to inspect improvements on the Mississippi River. During the course of the trip, their vessel, the ill-fated *Norman*, capsized and many were lost including a dozen members of the Society. A number, however, struggled to a sandbar in the river. Some of the later arrivals on this island were amazed to find a group that had reached there earlier huddled around a driftwood fire. In that group was a man of moderate height, friendly eyes, with stubby beard and mustache, calmly smoking a cigar. This striking picture is a typical characterization of John F. Coleman — resourceful in emergencies, uncomplaining of his lot, calm in the face of difficulties, and rising superior to every handicap.

He was born in Mississippi shortly after the close of the Civil War, but like the character in the old song, "he was bred in New Orleans." Practically all of his life has been spent in that southern metropolis. As a boy he attended the public schools to prepare himself for his life work. Like many another engineer of his day, he found that opportunity beckoned him in the field of railway location and construction, but not for many years. He soon settled down again in New Orleans and there for more than 40 years he has been active in the engineering problems of the South. A short term in this long period was devoted to serving his adopted city officially as assistant city engineer. The great bulk, however, was in varied consulting work.



JOHN F. COLEMAN

It is in these notable engineering accomplishments that Mr. Coleman has become known far and wide. Hydraulic projects have demanded much of his attention. Port development and its allied subjects of river and harbor improvement work have engaged him deeply. He has not lived next to the Father of Waters for most of his life without taking a keen interest in its behavior. As a student of the lower reaches of the Mississippi River, he stands second to none, and he has been accorded by engineers preeminence as an expert on the highly debatable and technical problems concerned with its hydraulics and control.

Starting with his successful experiences in and around New Orleans, he rapidly developed into one of the leading marine terminal engineers of the entire South. Houston, Tex.; Jacksonville, Fla.; and Richmond, Va., are among the cities which have called upon him for advice, while large industrial firms by the score have availed themselves of his services. His knowledge and wide experience in the field of foundation problems, particularly of the lower Mississippi alluvial valley, have made him a recognized authority.

These successes have brought to Mr. Coleman merited recognition from various sources. When the depression became serious in its adverse effect on construction, President Hoover singled him out as one of the five members of the Engineering Advisory Board of the Reconstruction Finance Corporation. In this capacity he was enabled to cooperate in putting under way those improvements of a self-liquidating character which might be quickly inaugurated to relieve unemployment. The entire engineering profession accorded him one of its highest honors when he was made president of American Engineering Council in 1934 for the usual two-year term. He has served as president of the American Institute of Consulting Engineers, while his many honors in the Society, even to the presidency, are well known.

It is hardly to be wondered at, then, that in his home city and among those who are best acquainted with him, he stands preeminent through his long association with the varied civic activities of New Orleans. Both in connection with its cultural development and its commercial progress, he has won the hearts of his fellow man. The city has laid claim upon him as one of its first citizens, and he is without doubt its first engineer citizen. As evidence, in 1935 Tulane University bestowed upon him the degree of doctor of engineering, its highest academic honor. That he is without formal engineering training makes this recognition from one of the old colleges of the South the more remarkable. He is therefore the exception that proves the rule of the "prophet without honor except in his own country."

Among his friends, who are legion in New Orleans, as well as elsewhere, he is known as "Frank." Many are the anecdotes they tell, which attest to his tact, his wit, his dignity, and above all, his personal and professional integrity. His life has exemplified throughout the highest ideals of that splendid type of southern gentleman of the old school. In every Society gathering he is outstanding for his geniality and wit. In recent years it has been possible for Mrs. Coleman to accompany him on many of his trips, and thus members have come to know one of the inspirations of his splendid character. The mutual love, solicitude, and consideration always existing in the family are the outstanding and endearing qualities of the Colemans.

As time has permitted in an extremely busy life, Mr. Coleman has found opportunity to enjoy the relaxation of golf. Community betterment and the welfare of the engineering profession, however, might well be considered his hobbies. Throughout his life he has been a student and an omnivorous reader. These qualities, coupled with his keen gift of common sense, have made his opinions much sought after and highly regarded.

Under the thrill of great honors and the strain of great trials, he has maintained his poise, dignity, and restraint. He has figuratively "talked with kings, nor lost the common touch." His friends feel that it was a kind providence, indeed, that protected him from the *Norman* tragedy because there was worthy work for him to do. Of his value to the world and to engineering, the granting of honorary membership is but one token. The profession earnestly hopes that he will have many future years of usefulness for the further fulfillment of his great potentialities.

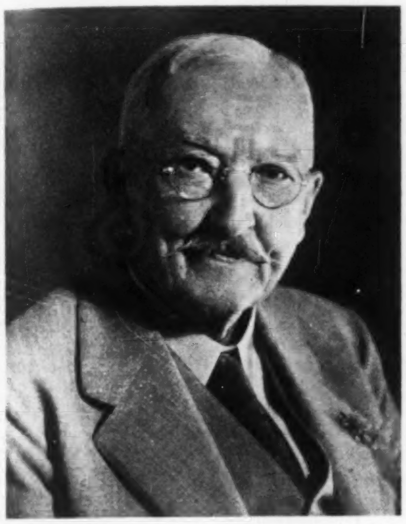
MORTIMER ELWYN COOLEY

Over sixty years ago two youths met in Baltimore. One was from Louisville and the other from a small town in western New York, but both were headed in the same direction—to Annapolis to enter the U. S. Naval Academy. That meeting was the beginning of a lifelong friendship. Entirely aside from their mutual attraction for each other, these boys were to find their lives running in parallel courses. They roomed together; they graduated together; they took the same cruise upon graduation to foreign ports in the old Quinnebaug; and eventually they were both conscripted out of the navy and into the field of engineering education. Mortimer E. Cooley became the outstanding teacher in Michigan, and Ira N. Hollis similarly served New England engineering schools, Harvard and Worcester, long and illustriously.

When Mortimer Cooley was a lad, in those days immediately preceding and following the Civil War, his home was near Canandaigua, N.Y., in the thriving agricultural country tributary to the Finger Lakes region and the Erie Canal. Educationally, he was the product of those great twin mentors, the American farm and the district school. With these as a background plus some teaching in the local academy, he braved the entrance examinations to Annapolis. There hard work and responsibility built on his firm foundation, while his tour of sea duty added to this liberal education an acquaintance with people and places. So the farm boy broadened his outlook and emerged from this experience a traveled, well-rounded man.

This trip did more for him than merely to show him places and things. He had his first intimate contact with engineering problems. Since then he has admitted that this early cruise meant more to him in terms of practical steam engineering than all his subsequent experience.

In August 1881, Ensign Cooley was assigned to the University of Michigan to inaugurate a course in mechanical engineering, or as it was called in those days, "Steam Engineering and Iron Shipbuilding." Thus began a contact which has lengthened and strengthened over almost 55 years. In 1904 he was placed in charge of all engineering work at the university, and so as "Dean Cooley" he is affectionately known to thousands of Michigan engineers and to a vast circle of friends throughout the entire country. He has seen the registration mount from 65 engineering students when he went to the university to as many as 2,500, including those in architecture, just after the Great War.


Mortimer E. Cooley

Such a long and notable experience has been productive of various duties and honors. In 1900 the Michigan Railroad Valuation was undertaken by him, followed by other notable successes in the following 25 years. In his home city of Ann Arbor he yielded to his sense of public duty to become president of the Advisory Council of the Joint Commission on Public Service. His latest public service has been as state engineer for the Public Works Administration in Michigan, which office he has held since 1933.

Engineers have delighted to honor him as one of the illustrious members of the profession. He is a former president and honorary member of the Michigan Engineering Society. Similarly, he has received the greatest honors in the American Society of Mechanical Engineers. From 1921 to 1923 he was president of the Federated Engineering Societies, which has since become American Engineering Council. He has been a member of the Society for 25 years and served as Director from 1914–1916. Three universities have given him doctor's degrees and as a sort of "summa cum laude" he was granted the Washingtom Award in 1930 for outstanding service to the profession.

Apparently there is no end to the recognition given him by his adopted state. His most recent honor was received when, on September 15, 1935, a bridge across the Manistee River in the Manistee National Forest, was named the Mortimer E. Cooley Bridge, with the comment that "wherever the principles of engineering as taught at the University of Michigan are practiced, Mortimer E. Cooley will be remembered as a kindly, understanding, intelligent dean. Whenever in Michigan distinguished public service is appreciated, this man will be remembered for his patriotic conception of his public duty."

Dean Cooley is a good example of the well-known fact that nothing begets loyalty as well as loyalty itself. Everyone who has worked with him knows that he will give him the most sincere support and when the job is done he will see to it that due credit goes to everyone, particularly to the workers.

If there is one thing his wide experience has ingrained in him, it is the quality of tact. He should be in the diplomatic service. Just one of many examples will illustrate. He was chairman of a board which had tackled a knotty problem. An important bridge was to be built over a channel which, while technically navigable practically was never used. Further, the cost and difficulty of providing the movable span proposed would be considerable. Instead of recommending that this undesirable element be omitted, Dean Cooley's method was quite different and much more effective. He called in the navigation interests concerned and explained the matter in such a way that the very solution he wanted was suggested by the shipping officials themselves. In two weeks the whole matter was arranged to everyone's complete satisfaction.

To maroon a sailor in the Middle West would ordinarily be to make a "landlubber" out of him; but not with Dean Cooley. Fifty years has not been enough to swerve him from his first love. For 16 years he served as chief engineer of the Michigan State Naval Brigade. In the Spanish-American War he was chief engineer on the *U. S. S. Yosemite* and later was in charge of construction at the League Island Navy Yard. During the World War he asked for service at sea—not in an office. Still the tang of the salt sea runs strong in his veins. His letters are replete with nautical phrases and idioms. To get him together with some of his old navy cronies, such as was the late President Hollis, is to ensure a rollicking hour of jolly reminiscence.

Thus a brief picture of the converted farmer boy. Add to the elements of fairness, sense of justice, and diplomacy, a delightful personality, the ability to select a good dinner and tell a good story—"spin a good yarn" is the way he would put it—occasionally to lapse into poetry of sorts, and you have the combination that his friends call Cooley. A wonderful combination it is!

William J. Wilgus

From the terraces surrounding Col. W. J. Wilgus' beautiful Georgian home near Ascutney, Vt., there is visible a railroad bridge, the abutments and piers of which were designed and built by Whistler some 90 years ago. To most persons the name Whistler suggests the artist who used to sign his paintings with a butterfly signature. It was the artist's father who was among the greatest of early American railroad engineers, so great that the Czar of all the Russias called him to St. Petersburg and commissioned him to build the famous St. Petersburg to Moscow railroad. Somehow to those who know Colonel Wilgus well there is something peculiarly fitting in his having established his home in all the beauty of the upper Connecticut valley on a spot from which there is at all times visible the work of one of America's greatest engineers.

The layman's knowledge of the senior Whistler is matched perhaps by the familiarity of the present generation of engineers with the outstanding accomplishments of Colonel Wilgus. He was born in Buffalo, N.Y., November 20, 1865. After a high school education he entered railroad work in 1885 on what is now the Chicago Great Western. This engagement was followed by miscellaneous duties on other western roads until 1893 when he joined the New York Central Railroad system as an assistant engineer.

On April 15, 1899, when he was only 33 years old, he was appointed chief engineer of the New York Central Railroad system. Even more remarkable, on January 30, 1903, when only a little over 37 years old, he was appointed fifth vice-president in general charge of all construction work and maintenance of way and structures. During this meteoric career the rehabilitation, improvement, and expansion of the railroad system, including its leased lines, the electrification of the New York suburban zone, and the inception and carrying to substantial completion of the new Grand Central Terminal in New York City predicated on the utilization of air rights were among his outstanding accomplishments.

William J. Wilgus

After leaving railroad work, in 1907 he entered private practice, which he continued until 1931, interrupted only by his distinguished war service. During all this period his ability was in continuous demand as consultant on railroad, municipal, transportation, valuations and public utility enterprises of major importance. He also gave generously of his time for the public good in the protection of the Mall, Washington, D.C., and the protection of Morningside

Park and High Bridge Aqueduct, New York City, and in connection with the erection of fallen columns at the Parthenon, Athens, and the establishment of a national park in the Green Mountains of Vermont. He has also served as a member of the Municipal Art Commission of the City of New York, as a member of the Fine Arts Federation of New York, and as a member of the National Academy Association.

In 1931 he retired to his estate at Ascutney, Vt. Anyone visiting him here gets a better measure of the man than is obtainable in almost any other way. The beauty of the house and grounds, the charm and culture they reflect, are characteristic of the man himself. Colonel Wilgus is a veritable dynamo of tireless energy, possessing an extraordinary and penetrating mind of unusual capacity together with ability to make important and fundamental decisions in the midst of trying, irritating, and multitudinous details. With these attributes he couples a remarkable sweetness of character, a Chesterfieldian courtesy, and a warmth of hospitality which have won him hundreds of friends throughout the engineering profession in this country.

In August 1934 in response to the call of public duty he became director of the Works Division of the Emergency Relief Bureau of the City of New York, having charge of about 3,000 construction jobs, involving expenditures at the rate of $120,000,000 a year and employing on an average of 120,000 workers, including more than 1,900 engineers. When he again retired to private life in May 1935, the Emergency Relief Bureau of New York City, the central body handling the great relief problem of that metropolis, unanimously passed a resolution setting forth in glowing terms their thanks and that of the City of New York to Colonel Wilgus for the magnificent work he had done in reorganizing and markedly improving the work relief activities within the short period of nine months.

Colonel Wilgus' war record is well summarized in the citation personally awarded him by General Pershing himself which read as follows:

> "For exceptionally meritorious and distinguished services, as Delegate of the Special Railway Commission, Director General of Military Railways and Deputy Director General of Transportation. In all of these positions he has demonstrated exceptional ability and untiring energy. The foundation of the Army Transportation Service was largely due to his vision and remarkable judgment. He has shown a degree of devotion to duty far above any calls which would have been made upon him by military authority."

Later he became a colonel in the Corps of Engineers of the U. S. Army and was recommended for advancement to the grade of brigadier general personally by General Pershing just prior to Armistice Day. It was only the resolution of the U. S. Senate prohibiting promotions to the rank of general after the Armistice which denied Colonel Wilgus a fitting and a much-merited star on his shoulder.

He has found time, despite the pressure of his great accomplishments, to contribute liberally to the technical press. The quality of his contributions is measured by his winning the Thomas Fitch Rowland Prize of the Society in 1909 and the Telford Gold Medal of the Institution of Civil Engineers (Great Britain) in 1911. In addition it is generally admitted that the final report of the Committee on Valuation of Public Utilities, published in the Society's *Transactions* in 1916, of which Committee he was a member, was one of the most authoritative documents of its kind. In 1931 Colonel Wilgus published a monumental treatise entitled *Transporting the A.E.F. in Western Europe*, now widely used in the U. S. War College.

He has also been awarded the following distinctions: Grand Prize, St. Louis Exposition (contributor to American Society of Civil Engineers exhibit, 1904); honorary membership, American Institute of Architects, 1916; Distinguished Service Medal and Citation (U. S. Army), 1919; Cross of Officer Legion d'Honneur (France), 1919; honorary degrees in engineering (Stevens Institute of Technology, 1921, and University of Vermont, 1927); Conspicuous Service Cross, State of New York, 1932; and other honors.

Colonel Wilgus' election to honorary membership is a peculiarly fitting tribute to a self-made engineer who, without the advantage of a college education, has brought distinction to the profession and whose works are enduring monuments to American engineering skill.

Meeting of Executive Committee—Secretary's Abstract

ON DECEMBER 16, 1935, the Executive Committee met at Society Headquarters in the Engineering Societies Building, New York, N.Y. Present were President Tuttle, Secretary Seabury, Past-Presidents Eddy and Hammond, Vice-President Sawyer, the Treasurer, Mr. Hovey, and the incoming President, Dr. Mead.

The principal item of discussion was the budget for 1936. Attention was also given to a thorough analysis of the Society's policies and procedures—such as the Society's efforts to promote the reemployment of engineers; salary surveys; the progress of registration; the increasing membership of the Society; the work of the research committees and of the Technical Divisions; the Society's publications; the means of bringing about a closer relationship with the Local Sections and with members not affiliated with Local Sections; and the value of the work of the Field Secretary, both in observing conditions at the several Local Sections and Student Chapters he has visited and in explaining to them the activities of the Society. The entire day was spent on financial and administrative matters and analyses of the Society's policies.

Budget Preparation Involves Detailed Study of Society Activities

PREPARATION OF THE BUDGET for 1936 was pushed forward rapidly at the December meetings of two important Society committees. On December 14, the Committee on Publications completed the estimate of its budgetary requirements for the year, and two days later the Executive Committee gave attention to 13 composite items of prospective income and 34 similar items of prospective expenditure.

Study of the budget began long before the formal consideration given it at these meetings, with requests to all committees and Technical Divisions for an estimate of the expenses they anticipate in the prosecution of their work. Each of these estimates was accompanied by an outline of the work to be accomplished. Meanwhile a detailed analysis of the entire situation was begun by the Headquarters staff. Comparative figures of actual income and outgo for the preceding several years were studied in relation to changing conditions.

One major item of income that has been especially hard to estimate since 1930 is receipts from dues. Among the important considerations on the debit side of the ledger are the anticipated costs of paper for the publications; expenses incident to the various Society meetings; the required size of the staff; the cost of badges and certificates; and the cost of postage at first class, second class, third class, and pound rates. This year two new sealing and stamping machines and a new addressograph are needed, and the market was canvassed thoroughly for the most desirable and practicable equipment.

In preparing the publication budget the staff had first to estimate the size of the several issues of each of the publications—TRANSACTIONS, PROCEEDINGS, CIVIL ENGINEERING, reports, Manuals, and reprints—and the the number of copies required of each. The latter figure takes into account both the estimated increase in membership and the sales to non-members. Such sales, incidentally, yield upward of $10,000 per year. The results of these preliminary studies were carefully analyzed by the Committee on Publications and revised as seemed desirable. (This Committee, in addition to studying the budget, gave consideration at its December meeting to 33 items, including papers submitted for PROCEEDINGS and TRANSACTIONS.) The estimate was then transmitted to the Executive Committee for inclusion with the other budget items.

The complete budget as finally drafted will be presented to the outgoing Board at its meeting on January 13–14, 1936, when, with such amendments as may be made, it will be recommended to the incoming Board for adoption. That Board, at its meeting on January 16, has the opportunity of making further amendments before taking final action.

The Name—"Proceedings"

THE FOLLOWING significant words are quoted from the presidential address of the late James Kirkwood, M. Am. Soc. C.E., second President of the Society:

> "In another and more important point, as some will view it, we were deficient. For this deficiency all of us were to blame without exception, I believe. I allude to the absence of professional communication from the members one of which is wanted at every general meeting, to induce a fair attendance, to elicit discussion, and incidentally to provide the channel or bond of intercourse between us. . . . Because we are so widespread, so far apart from each other, and where besides we are not so frequently called to any metropolitan center as are the professional men of England and France, we shall find it more needful to create this other tie and to maintain it by a regular distribution of so much of the proceedings of general meetings as will be readable and valuable to the absent members."

Enunciated in 1867, after fifteen years of relative inactivity on the part of the Society, the foregoing statement of policy marked the beginning of a long and lasting growth. In those days the membership numbered considerably less than 200, and it was the custom to meet regularly for the reading of a technical paper later to be discussed by letter or by comment from the floor. The PROCEEDINGS at that time constituted a complete record of all the happenings at the meetings. The major purpose of the meetings was to discuss technical problems of interest to engineers and architects, although the PROCEEDINGS included such records as "Notes from the Committee on Paper and Printing" and other items of general interest to the Society.

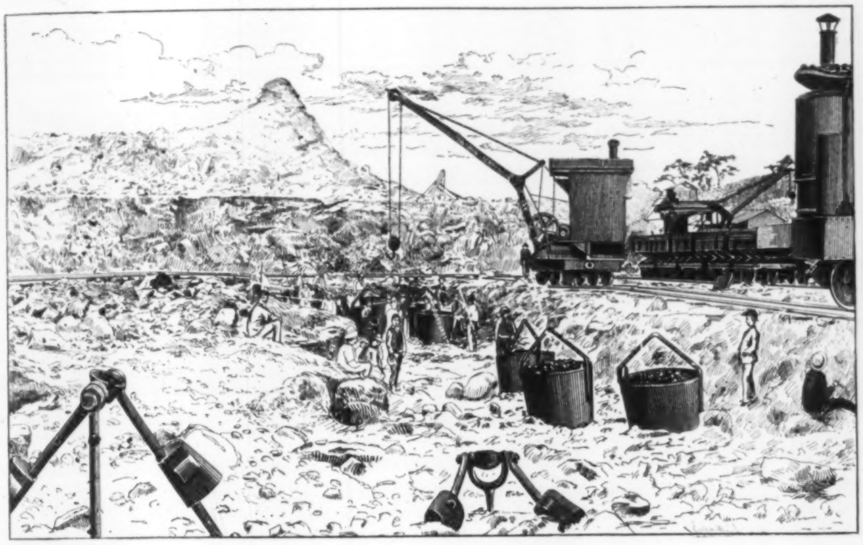
In the 68 years that have followed the clear expression of these principles, the Society has increased in membership a hundred fold. The PROCEEDINGS has been changed as to appearance, paper, typographical style, and other minor factors; but the central purpose that has caused it to be called "Proceedings" from the very first is the same today.

As of old, the members meet together to study a technical paper by one of their number and to discuss it from all angles. With the larger membership the meeting hall is now more than three million square miles in extent, and PROCEEDINGS holds a position of correspondingly greater responsibility. The significance of the name "Proceedings"—as an instrument to assimilate the technical "happenings" of the Society—remains the same as ever.

A clear distinction is indicated, then, between the newer publication CIVIL ENGINEERING and the older PROCEEDINGS. Because it contains something essentially new, which may or may not influence the future course of the profession, the PROCEEDINGS paper is intended to incite discussion on the part of the forward-thinking members of the profession.

The aim of a PROCEEDINGS paper is to establish a fact; a CIVIL ENGINEERING paper serves to keep the established fact alive and to make it useful by presenting in an attractive light examples of good practice.

It follows that presence or lack of mathematical theory, complicated line drawings, attractive photographs, and brevity of presentation, in themselves, do not decide whether a paper should be printed in one publication or the other. If a new technical question is raised that deserves careful study and a serious answer, that question should be presented in PROCEEDINGS. By so doing the Society will continue to grow professionally and so fulfil the destiny ascribed to it prophetically in its youthful days.



CHURN DRILLS AND CRANE BUCKETS USED BY THE FRENCH ON THE PANAMA CANAL
From an Old TRANSACTIONS Paper Read July 7, 1888

Some Dyerisms

THROUGHOUT the South, Gus W. Dyer, Professor of Economics at Vanderbilt University, is known far and wide for his fascinating and humorous addresses. An example of his scholarly and interesting presentation was given in the abstract of his remarks before the Birmingham Meeting, as briefed in the December 1935 issue. Other excerpts from his witty address, although separated from the context, will nevertheless amuse many engineers. Illustrations follow:

Whatever you may say about the depression, it is certainly making everybody think—who is capable of thinking. Of course that does not apply to very many, but all who can think are certainly thinking now. And they are very much like the old negro who was sitting down by a tree on one occasion with his head in his hands; he seemed to be worried and in a deep study. A man came along and asked, "Uncle, what is the matter?" "Why, Boss," he answered, "I is thinking about the things I done forgot."

* * * *

A good many business executives not only are thinking but are worried and their status is very similar to that of a lawyer I heard of in Kentucky. A young fellow who wanted to practice law went before the judge to take his examination. The judge asked him what he had studied. He said he had not studied Blackstone or any other recognized authorities, but he had specialized in the statutes of Kentucky. "I think," he said, "I can answer any question you may ask me on any important statute of Kentucky." The old judge said, after thinking a moment, "Son, to be frank with you, I am going to tell you the trouble you are going to have as a lawyer is that the Kentucky Legislature may meet next winter and repeal every damn thing you know."

* * * *

The first experience that Dick Reynolds had was driving a wagon around through the mountains, peddling tobacco. He was working with his brother who owned a small factory. His brother was discouraged when he learned that Dick had swapped off the tobacco for jewelry, finger rings, and things like that. That was the beginning of the work of R. J. Reynolds. And just think of the effrontery, the presumption, of a mountain boy coming out of the greatest depression any country has ever seen and presuming that he could get into the tobacco business! But he came out of the mountains announcing to his rich and powerful competitors that the "Camels" were coming—and they have been coming, too.

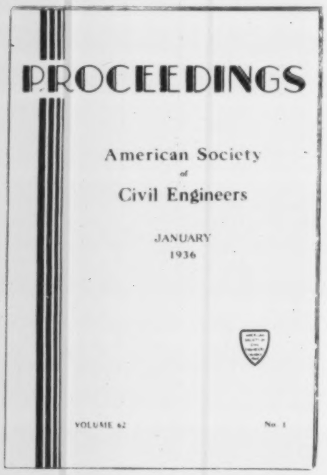
* * * *

Benjamin Franklin discovered electricity. Somebody said all great discoveries were made by married men. I don't know whether that is so or not, but it is true that Franklin discovered lightning two weeks after he was married.

* * * *

Some years ago they impeached a judge in Tennessee. The chief witness against him was a gambler from Memphis. I will never forget his testimony. They wanted to break down his testimony and bring out that he was a professional gambler. The opposing counsel said to him, "You bet on horse races, don't you, in Memphis?" And he said, "Yes sir, a good deal." And he asked him, "You bet on chicken fights," and the answer was, "Yes." Then he asked him, "You bet on prize fights," and he replied, "No, I never bet on anything that talks."

A New Cover Design and Better Paper Stock for Proceedings



PROCEEDINGS

American Society of Civil Engineers

JANUARY 1936

VOLUME 62 No. 1

BETTER REPRODUCTION of the photographs appearing in PROCEEDINGS will be noted in the forthcoming issue of that publication. This improvement has been made possible by the use of a higher grade of paper—known as English finish—which has a better printing surface. The appearance of line drawings and text material will also be improved, for the weight of the new paper adds to the opacity of the sheet and to a great extent will prevent the print from showing through. Readers will find that at the same time the "feel" of the PROCEEDINGS has been improved, not only by the substitution of the heavier text paper but by a more substantial cover stock as well.

In addition the January issue will introduce a new cover design. This change has been given very careful consideration, for the Committee on Publications feels that a publication with the long history and wide recognition of PROCEEDINGS has a "personality," sensed even in the cover, that should not be modified needlessly. The new format is believed to preserve this personality while adding to the general attractiveness.

Triborough Bridge Interests Metropolitan Student Chapters

ON FRIDAY EVENING, December 6, 1935, there was held in the Engineering Societies Building the third annual Fall Conference of Metropolitan Student Chapters, instituted in 1932 to bring together the students in the eight Chapters within the 50-mile metropolitan radius. Approximately 200 members of the Chapters, their faculty advisers and contact members, attended the meeting.

The speaker of the evening was Mr. E. Warren Bowden, Assoc. M. Am. Soc. C.E., assistant to the chief engineer of the Port of New York Authority, who gave an illustrated talk on the Triborough Bridge. This structure, now rapidly nearing completion, is almost within sight of some of the institutions represented among the Chapters. Mr. Bowden's talk proved to be of absorbing interest, as he took special pains to show why certain decisions had been made and why certain procedures had been adopted. These characteristics of a lecture appeal particularly to engineering students, and the applause at the end indicated that this group was heartily appreciative. Mr. Bowden's lantern slides also were carefully chosen and well presented.

Robert Ridgway, Hon. M. Am. Soc. C.E., chairman of the Metropolitan Section's Committee on Student Chapters, spoke briefly at the opening of the conference, as did Secretary Seabury of the Society and also Mr. Richmond, Assistant to the Secretary. Refreshments were served afterwards.

The Conference of Metropolitan Student Chapters operates under the friendly guiding hand of the Metropolitan Section, which also generously assumes responsibility for the cost of holding the Fall Conference at the Engineering Societies Building. The Spring Conference is held in April or May with one or more of the Chapters acting as host on its own campus. At the Spring Conference student papers are presented and prizes awarded, the latter being financed by the Conference Chapters themselves. The Chapters in this group are located at the Polytechnic Institute of Brooklyn, the College of the City of New York, Columbia University, Cooper Union, Manhattan College, Newark College of Engineering, New York University, and Rutgers University.

An unusual camera study of the Triborough Bridge appears in this issue as the "Page of Special Interest." The Society is indebted to Ralph H. Mann, M. Am. Soc. C.E., for his skill as an amateur photographer in obtaining such a striking view.

Engineers Asked to Encourage Expansion of Mapping Program

FOR FOUR YEARS, the Society has made persistent efforts to bring effective public attention to the need for expanding the program of mapping the United States. In line with these efforts, the Secretary has recently sent to all Local Sections a letter suggesting that members of each Section appraise the value, to their region and to the public at large, of an expanded program of topographic mapping, and that they present the facts promptly to the President, to members of Congress, and to the proper federal administrative officers.

Prompt action is necessary, for the expanded program, if adopted, will be carried on under normal government procedure through regular budgeted appropriations to be made by the Congress now convening. It is understood that budgetary applications permitting a reasonable expansion of work have already been made by the directors of the two federal bureaus involved—the Coast and Geodetic Survey and the Geological Survey.

The proposed work is in accordance with the plan of the Federal Board of Surveys and Maps (published in full in the February 1935 issue of CIVIL ENGINEERING) for completing the topographic mapping of the country within the next ten years. Up to the present such maps have been prepared for only 47 per cent of the total area, and more than half of these are so out of date as to be almost valueless. It is important that engineers, appreciating the value that would accrue to the public from the availability of proper maps, should make earnest efforts to lay the facts convincingly and without delay before the proper officials.

A memorandum from Frederick M. Feiker, executive secretary of American Engineering Council, reports that at a recent meeting of the Federal Board of Surveys and Maps, two resolutions were passed: (1) requesting Council to take the leadership in forwarding the mapping program, especially in finding ways and means to secure funds at the next session of Congress; and (2) volunteering the services of the Board to work with Council in developing basic information with regard to the program.

Society Assisting in Initiation of Newly Approved Local Control Surveys

THE WORKS PROGRESS ADMINISTRATION has approved the allocation of work relief funds to local geodetic control surveys in the several states, and local WPA administrators have been so advised. For these surveys, the following bodies have been named as "sponsors": state public works commissions; engineering departments of states and other political subdivisions and municipalities; state educational institutions; state highway departments; and state and city planning boards; with the cooperation of national and state engineering organizations.

The work is to be under the general guidance of the Coast and Geodetic Survey, which will provide members of its staff as advisers, furnish some instruments and forms for field and office work, and supply general rules of good practice to the end that the work done will be useful and worth while. Although most of the persons to be employed will be taken from relief rolls, there will be a number of engineering supervisory positions not thus limited.

All Local Sections of the Society have been written to and urgently requested to make a definite search not only among Society members, but also among those who are not Society members, to the end that as many engineers as possible may thus have reemployment in the supervising positions. The group of volunteer "employment correspondents" scattered throughout the country and organized early this year through the medium of the Local Sections, has also been advised. This group has been asked to report to Society Headquarters the extent to which such projects are undertaken and the number of engineers thus engaged.

Attitude of Construction League to Further Works Appropriations

Continuation of a program of useful public works and elimination of wasteful construction projects were recommended by the Policy Committee of the Construction League of the United States in a statement issued on November 8, 1935. The statement, summarizing the attitude of the League toward further appropriations for public works, follows:

"The Construction League recognizes the need for the utmost reasonable economy in public administration in order to prevent excessive tax burdens and maintain the public credit and yet avoid any drastic increase in unemployment.

"The greatest opportunity for economies naturally will be found in connection with administrative and other overhead costs of government, but it is evident that the investment of the public credit in public works and facilities should be conducted with due regard to economy, efficiency, and the permanent values to be realized by the community.

"Accordingly, the Construction League recommends the following principles to govern the conduct of federal, state, and local public improvements:

"1. Elimination of the wasteful construction projects now carried on by WPA as a means of relief.

"2. Continuation of a substantial program of useful federal public works and of federal aid to highways.

"3. Continuation of PWA aid to states and municipalities for useful projects that add to the public wealth.

"4. Grants for state and municipal projects and emergency appropriations for highways to be on a descending scale in proportion to the increase in private employment.

"5. Ear-marking of all appropriations for particular purposes.

"6. Mandatory provisions that construction projects financed in whole or part by federal funds should be carried out in the normal manner through public lettings and contracts and the regular engagement of professional services without arbitrary and artificial restrictions."

Committee on National Water Policy Is Appointed

The Board of Direction has recently authorized the appointment of a committee to be known as the Committee on National Water Policy. The scope of the committee's work is to be "that of a unit to which is to be referred any proposed program of the National Resources Committee for consideration and test of its practicability under conditions existing in various parts of the country." In pursuance of the Board's order, President Tuttle appointed the following members to serve on the committee: L. K. Sherman, chairman; Donald M. Baker, M. C. Hinderlider, Lawrence M. Lawson, and A. D. Weston, all Members of the Society.

It appears that the procedure under which the Committee will operate will be that the National Water Resources Committee will keep the Society's Committee informed of any proposed program relative to the systematic collection and publication of hydrological data and of water supply, irrigation, and power studies. With this information in hand the committee members, selected as representative of widely separated parts of the country and of themselves intimately experienced in these subjects, will express their individual and composite impressions to the National Water Resources Committee for its guidance. A matter which is likely to arise will be the selection of some one or another drainage area to be comprehensively developed for water supply, sewage disposal, power, flood protection, navigation, and national defense, and it will be the duty of the Society's committee to appraise such proposed developments, and to transmit its conclusions to the chairman of the National Resources Committee.

Conference of Northeastern Student Chapters to Be Held January 16

The general success of recent Student Chapter conferences and evidences of healthy interest in Chapter activities has led to the decision to schedule a conference in New York at the time of the Annual Meeting of the Society. It will be held at 4:00 p.m. on Thursday, January 16, 1936, at the Engineering Societies Building, 33 W. 39th Street.

Representatives and members of the Chapters in the northeastern section of the country will thus have a chance to meet and discuss common problems, exchange experiences, and get acquainted. There will be opportunity early in the same day to attend Technical Division sessions, and in the evening to take part in the smoker. Small groups may plan to take supper together at nearby restaurants. On Friday and Saturday there are inspection trips as part of the Annual Meeting. Throughout the period there may be found opportunities to meet members of the Society and to get the feel of being at a Society Meeting. Numerous alumni gatherings may also be enjoyed.

Members of the Society generally, and all others interested, will be welcome to sit in at the conference. It is hoped that at least one representative of each Chapter in the vicinity will be able to attend and that as many other student members as possible will be present.

This conference is an innovation as regards the Society's Annual Meeting. Experience with similar gatherings at other meetings held in the spring and fall leads to the expectation that all those who can attend—whether students, members, or Society officers—will find it a most pleasant and profitable occasion.

Highlights of the Student Conference

Important Comments by Delegates and Others in Attendance at Birmingham, Ala., October 17, 1935

From as far away as the University of Oregon came representatives of Student Chapters to the conference held in conjunction with the Birmingham Meeting. Students were given an opportunity to see the Society "in action," and departed with a better knowledge of Society activities and a wealth of new ideas for the conduct of their local groups. For the benefit of the Chapters that were not represented, a few of the suggestions made at the conference have been abstracted in the following paragraphs.

Preparing the Student for Civil and Professional Life

"In the earlier days, the engineer was only a scientist. I think the time is here when the engineer should also be an executive. In my day, during my college course, there was very little opportunity to know what engineers were doing, to form acquaintances, to meet men. You are living in new surroundings, with opportunities such that when you start out at the end of your college course you will be in a position which it took your elders many years to gain. I have proposed that the responsibility of cementing the bond between the student body and the American Society of Civil Engineers be placed to a large extent upon the teaching institution and that when a man enrolls for a course in civil engineering a part of his curriculum be work in the Student Chapter. Let the teaching institution take over the Chapter and take responsibility for it. Perhaps the time has not yet come to do that, but I believe that it will come. I believe some of our teaching institutions have already taken this step, and I am hopeful that it will spread."—Arthur S. Tuttle, *President of the Society.*

"The thing that men in college do not get from their college curriculum is a view into the problems they are going to face in their civil life. It is my suggestion that Chapters bring in men that are out in the professional life—men that have not been in it too long—to tell them just what they can do to make themselves better citizens as well as better engineers."—N. R. HOWER, *President of the University of Alabama Student Chapter.*

"You will not have been out of school very long before you come into contact with the idea that engineers should have a place in the sun, that the engineer is not getting the notice from the public that he is entitled to. If that idea gets into your mind, reflect and see if you spent your time in school to the best advantage in preparing yourself to take a place in the sun. Are you personally constituted so that you will retire to the top of a school, in front of a drawing board, pull down your shade, stick a pipe into your mouth, and get out the slide rule, or are you one of those individuals who, as President Tuttle remarked, must be an executive? Between those two extremes of personal tendencies is the range of engineering. Your experience in your Student Chapter, in discussing the problems of engineering and of professional life, will determine very largely for you which one of those two ends of the field you are going to occupy. So when you give your attention to calling for speakers who will enlighten you on some technical phase of engineering, you may be slighting the opportunity which you owe to yourself for developing your own traits, for competing with your friend, getting his friendly criticism, and getting some outsider's thoughts on personal conduct in society."—HUNTER W. HANLEY, *Member of the Society's Committee on Student Chapters.*

"Registration—or licensing, as it is called for engineers—is going to make it very difficult for you men when you leave college to become practitioners. Medical men face that same thing. And when they go to college it is with the understanding they have got to fight that examination before the state medical boards. Anything you can learn during your Chapter life that will help you to meet that situation of being forced to take an examination before you can become a practitioner, and be permitted to sign your name as an engineer, is going to be time well spent. Preparation for that event should be one of the things in your Chapter work."—HUNTER W. HANLEY.

SHALL WE HAVE OUTSIDE SPEAKERS?

"I want to commend what has been said with regard to the value of students' providing their own programs from their own members. I am inclined to think there is nothing from which the Chapter will obtain greater benefit. A lecture from the outside occasionally is stimulating and interesting, but the real value comes very largely from what you do yourselves."—C. C. WILLIAMS, *Chairman of the Society's Committee on Student Chapters.*

"I think there are two things that should be taken into consideration in getting to a conclusion on this subject of outside speakers. Many of the universities do their teaching on the lecture system. The boys do not get a chance to get on their feet. There are other schools that have the recitation system. Now where there is a Student Chapter in a school that is working largely on the lecture system, I think one of the functions which that Chapter should perform is to insist that on every program some one of the students make a speech, or a talk or an address, even if it is only to introduce the speaker that they may bring in from the outside. On the other hand, where the boys are accustomed to getting up and speaking, let the Chapter work the other way and give those boys a rest and let them listen to someone else."—JAMES G. ALLEN, *Contact Member, University of Tennessee Student Chapter.*

"The Texas Section two or three years ago had a committee on engineering education. They prepared a questionnaire and sent it to all of the consulting and practicing engineers in the state. One of the questions was, "In what subjects do you feel engineers are the weakest?" Over 50 per cent of those who replied indicated that they felt that the students were weakest in English. Thirty per cent said they felt that mathematics was the weakest."—JOHN A. FOCHT, *President of the Texas Section.*

"Someone else here today was remarking about the courses in English. The report of one of the committees of the Engineers' Council for Professional Development places a value upon certain tests made this past year, attempting to determine what men will probably produce good engineers. Experiments so far indicate that the usage of English is going to be one of the best tests—probably better than mathematics. I suppose that that means concentration on a subject sufficiently to absorb it so well that you speak it with ease and with conviction to the other man. I recommend distinctly that in your Student Chapters you make an effort to develop usage of English."—GEORGE T. SEABURY, *Secretary of the Society.*

REGIONAL CONFERENCES AND ASSOCIATION WITH THE SOCIETY

"A great many things have been accomplished by these various Student Chapters in a cooperative way. Many of them have had conventions or group conferences together in various parts of the country. That activity seems to be increasing. The Chapters are getting a great deal of benefit from it, and it may be that there are groups or Chapters that have not considered having these regional conferences that may find for themselves some benefit from it."—WALTER E. JESSUP, *Field Secretary of the Society.*

"The suggestion has been made that the Chapters of the universities in the different states form some sort of confederation so that they can meet together and exchange views. That idea has been carried into effect in District No. 1, the District within fifty miles of New York City. There are eight colleges and universities in this conference. They have two joint meetings a year. A committee of Society members, not necessarily representatives of the Chapters, passes on papers that are submitted for the Spring Conference, the four that are considered to have the most merit being recommended for public presentation. The writers of the two best papers are given a reward, something like ten dollars apiece. It does a whole lot to encourage them."—ROBERT RIDGWAY, *Past-President of the Society, and Contact Member, Brooklyn Polytechnic Institute Student Chapter.*

"The Student Chapter, while it may be very active, may at the same time, by being too local, not get the benefit it should out of its affiliation with the American Society of Civil Engineers. We believe that a good contact member is essential to the success of a Student Chapter."—R. B. DOUGLAS, *Member of the Virginia Military Institute Student Chapter.*

"Once a year the St. Louis Section invites the three Student Chapters in the state of Missouri to a dinner meeting in which the St. Louis Section acts as host. It is free to all the students. The faculty members usually provide the automobile transportation and we have a large attendance. I think that this one event does more than anything else to stimulate interest among the students in the work of the Chapter."—HENRY C. BECKMAN, *Contact Member, Missouri School of Mines Student Chapter.*

New Manual for Student Chapters Contains Many Valuable Suggestions

THERE HAS JUST come from the press a *Manual for Student Chapters*, full of information helpful to Chapter officers, faculty advisers, and contact members. Its purpose, according to the prefatory note, is "to indicate how students in civil engineering may enrich their college courses by beginning those professional associations and contacts which, continued through life, are most helpful to the practicing engineer."

The new Manual is the product of much serious work by the present Committee on Student Chapters, consisting of C. C. Williams, chairman; R. L. McCormick, Hunter W. Hanly, Glen E. Edgerton, and T. J. Wilkerson, all Members of the Society. Several former members of the Committee also contributed ideas and helped formulate the scope of the work.

In 1929 the Society issued a pocket-size pamphlet, the edition of which was rapidly exhausted. The lean years which followed did not permit further printing of this document, and the new Manual is intended to replace it. The Committee hopes that ultimately, through use and helpful suggestion, the new Manual may become an even more comprehensive document.

"A Student Chapter may be a source of inspiration or it may be a drag depending upon the spirit and enthusiasm of its members." Again, the first essential of a good report is "to have the accomplishment of a meritorious program to report. . . ." The Committee appreciates that the proper spirit and enthusiasm is largely dependent on a realization of the aims and possibilities of the Chapter and on its relation to the Society at large. It has there-re taken pains to explain thoroughly the workings of the Society and the provisions that have been made for the benefit of the student groups. For example, the lantern lectures available from the Society are listed; the functions of the faculty adviser, contact member, and field secretary are defined; and a set of model by-laws for Student Chapters is presented.

Copies of the Manual are being distributed to the presidents, secretaries, faculty advisers, and contact members of the 112 Student Chapters, and to the secretaries of the 57 Local Sections. A limited number of extra copies are available through Society Headquarters.

Engineers Seek Yardstick for Boys Most Likely to Succeed

If a boy is proficient in mathematics in high or preparatory school is he likely to make a success of an engineering course in college? Suppose he is a good speller, or has a good vocabulary, or can write a good letter or report; do those accomplishments have any bearing on the question of whether or not he should take up engineering? These are some of the things that the Committee on Student Selection and Guidance, of the Engineers' Council for Professional Development, is working out.

Preliminary results indicate that the answer to the first question is "yes," which is not entirely surprising. A year ago eight well-known engineering schools, at the Committee's request, gave to their incoming freshmen the cooperative test in mathematics as developed by the American Council on Education. At the end of the year the rating of each student in this test was compared with his general scholastic average for the year, and a so-called correlation determined. If this coefficient were as high as 1 it would mean that the test was a perfect indication of what the student would accomplish during the year; if the coefficient were 0 it would mean that the test had no bearing whatever on what he would do in his first year at an engineering college. The general average for 1,767 students turned out to be 0.55, indicating that the mathematics test was an excellent indication of freshman accomplishments. Other tests have shown that the correlation between the first year and the other three years of a four-year course is high. If a freshman fails in but one subject the chances are that he will graduate in the regulation period of four years, but if he has more than one failure his chance is slim without summer school, tutoring, or correspondence courses.

Entering freshmen at the same eight engineering colleges were also given a special test in English, which was in three parts covering spelling, vocabulary, and usage. The resulting correlation between the English test score and the first-year average for all subjects in the engineering curriculum was about 0.40, or lower than for the mathematics test, but still indicative that a student proficient in the various branches of English is adaptable to engineering work. A less comprehensive study at one engineering college alone, showed that usage ranked far above vocabulary and spelling as an indicator of engineering aptitude. That is, one may be a poor speller and still be likely to succeed as an engineering student, but ability in the use of English is about as necessary as proficiency in mathematics. In other words, an engineer must be able to organize and express his thoughts in clear, concise English.

The Committee directed similar work at a larger number of engineering schools in September of this year, and the correlations begun last year will be continued throughout the entire engineering course. Other tests of engineering aptitude are also being developed. It has been found that ability in descriptive geometry is an especially good criterion of the probable success of a student in engineering curricula, and it is hoped that a test can be devised for potential engineering students that will measure the same quality of imagination that descriptive geometry does. At present, there is no thought that these tests will be used to exclude students from engineering schools, but the Committee is seeking tests that will aid in selecting better students and in assuring them that they have interests and aptitudes that are likely to assure their success in the engineering field. Dean R. L. Sackett, of the School of Engineering at the Pennsylvania State College, as chairman of the Committee, is directing the work.

Another important phase of the Committee's activities is the organization of guidance programs and procedures for the aid of preparatory-school students. Many of the local branches of the national engineering societies that are sponsoring the Engineers' Council for Professional Development have appointed committees to address high-school groups and to confer with individual students about interests, aptitudes, curricula, and fields of work. Professional engineers are especially active in this work in Milwaukee, Birmingham, Schenectady, Cleveland, Detroit, Atlanta, Kansas City, Sacramento, Baltimore, St. Louis, Providence, Philadelphia, and Washington. These engineers supplement the work of the vocational advisers at many schools. Wide distribution of a pamphlet, *Engineering, a Career—a Culture*, has been a valuable aid. This may be obtained for 15 cents from the Engineers' Council for Professional Development, 29 West 39th Street, New York, N.Y.

Though only one of the four major activities of the Engineers' Council for Professional Development, student selection and guidance is fundamentally the most important, for it seeks to awaken an interest in engineering in those young men—and an occasional girl as well—that are likely to achieve the highest success in the engineering field. If only the right men are encouraged to enter engineering schools, a long step will have been taken towards increasing the recognition accorded to the profession.

New Memoirs of Deceased Members Available

In line with its regular policy, the Society has made available the preprints of 15 additional memoirs of deceased members that are being held for inclusion in the 1936 Volume of Transactions. A limited supply of these preprints are distributed free of charge to relatives and close friends of the deceased. The list of new memoirs is as follows:

William Valorus Alford	1858–1935
Ruel Keith Compton	1869–1935
Francis Elihu Crane	1861–1935
Charles Guy Eldredge	1886–1933
Morris Hansford	1865–1935
Frederick William Lovell	1872–1934
Luis Matamoros	1859–1934
William Mulholland	1855–1935
Arthur O'Brien	1870–1935
William Merit Penniman	1868–1934
August Lyon Phillips	1860–1935
Charles Frederick Swigert	1862–1935
Asahel Clark Toll	1880–1934
Henry Felix Wilson	1867–1935
Jackson Franklin Witt	1869–1935

Juniors Active in Colorado Section

The membership of the Colorado Section, after fluctuating for several years, reached a new high of 110 in 1935. This gain is largely due to increases in federal engineering personnel, particularly in the Bureau of Reclamation. Many of the new members are Juniors, and these have shown their interest by helping to organize the Junior Association of the Colorado Section, now in its second successful year. It is hoped that Juniors in other parts of the country will carry on the precedent thus established. Two of the Juniors have been appointed assistants to F. C. Carstarphen and P. S. Bailey, president and secretary, respectively, of the Colorado Section. The preceding information has been made available by H. J. Tebow, of the Junior Association.

In the interesting annual report of the Colorado Section for the year 1934–1935, recently received at Society Headquarters, it is stated that "there is a growing demand for Section activities to better the economic status of the engineer, to gain public recognition of the profession, . . . and to protect the local engineer against improper outside competition." Another passage of the report may well be referred to. This points out how much active participation of individuals in Local Sections can mean, and urges that gains in membership in the Society should be reflected to a greater extent in increased Local Section membership.

Society Represented at Scientific Congress

A REPORT of the transactions of the Engineering Section, Seventh American Scientific Congress, has been submitted by E. W. James, M. Am. Soc. C.E., the Society's representative to that body. The congress convened in Mexico City in September 1935, and Mr. James was made first vice-president of the Engineering Section.

Twenty-six papers in all branches of engineering were presented. Among those of special interest to civil engineers were one describing the experimental procedure followed in the works of the port of Mazatlán, two on methods that should be adopted for engineering research, one reviewing road construction in Mexico with particular reference to the Pan-American highway project, and one presenting a solution to the problem of preparing foundations in unsatisfactory subsoils like that of Mexico City. In the course of time a complete set of abstracts will be made available.

Members Exempted from Payment of Dues

TO POINTS as far distant as Lima, Peru, and Victoria, Australia, letters were sent last month bearing the good news that the recipients were thereafter exempt from payment of dues as members of the Society. In all, 128 members were thus exempted, having come under the provision that they are 70 years of age and have paid dues as corporate members for 25 years, or that, being less than 70 years of age, they have paid dues as corporate members for 35 years.

The geographical distribution of this group well illustrates the world-wide influence of the Society as a whole. In addition to the residents of the southern hemisphere, already mentioned, the group includes members in Cuba, Canada, and the Channel Islands, and in all parts of the United States from Portland, Me., to San Diego, and from Atlanta to Seattle. Among them are one Past-President, two former Vice-Presidents, four former Directors, and two Honorary Members.

Acknowledgments have already been received from a large number of this group. One man, proud of his long-continued membership, has mounted the 36 canceled checks, to form an attractive wall display.

Another writes:

"I am surprised to be exempt from further payment of dues. I thought dues and taxes went on forever."

And another:

"This is a solace for the regret that comes with passing years. If you can find some way of holding back the progress of time in so far as age is concerned, you may count on my willingness to continue my annual dues."

Finally:

"I realize that I could have done more for the Society, but hope that if I have had any influence on it, apart from the payment of dues, it has been for its welfare."

THESE MEMBERS HAVE EARNED THE RIGHT TO EXEMPTION FROM PAYMENT OF SOCIETY DUES

Allen, William A.
Amburn, William W.
Anderson, J. T. N.
Anthony, Charles
Bannister, Carl Lincoln
Bard, George Parker
Barney, Percy Canfield
Bell, Alfred Carroll
Bellinger, L. F.
Bellows, Oscar Francis
Bentzon, Adrian Benoni
Berry, George
Bishop, William Israel
Boyd, James Churchill
Brace, James Henry
Bradley, Frank Edward
Brumley, Daniel Joseph
Buel, Albert Wells
Carlile, Thomas Jenks
Cary, Edward Richard
Chapleau, Samuel Jefferson
Chase, Russell
Code, William Henry
Cole, Burt
Coleman, J. F.
Collins, D. C. Newman
Cooley, Mortimer E.
Coombs, Stephen E.
Cooper, Hugh Lincoln
Cowper, John W.
Crocker, H. S.
Cullen, James F.
Degen, Otto William
Dennis, Arthur C.
Dimon, Daniel Y.
Donham, Benjamin C.
Dorrance, William Tully
Dose, Henry F.
Dyer, Arthur J.
Earle, Thomas
Eavenson, Howard N.
Eckel, Edwin C.
Elliott, James R.
Endemann, Herman K.
Eno, Frank H.
Farley, Philip P.
Ferguson, John N.
Fickes, Edwin S.
Fitz Gerald, C. C.
French, Owen B.
Garrett, John T.
Garrett, Robert P.
Green, Andrew H.
Green, Bernard L.
Gregory, John H.
Hain, James C.
Haines, Eugene G.
Hanna, John H.
Hardison, Allan C.
Hardy, George F.
Hauck, William
Hawley, George P.
Heindle, William A.
Hem, Halvor O.
Hill, Louis C.
Hill, Walter H.
Hobby, Arthur S.
Hoffmann, Robert
Holmes, Glenn D.
Honens, Frederick W.
Honness, George G.
Howell, Franklin D.
Hussy, Ernest B.
Innes, Harry C.
Jacobs, Joseph
Johnson, Lewis J.
Johnson, William Edward
Keays, Reginald H.
Keller, Charles L.
Kelley, James A.
Kerr, Halbert S.
Knight, Herbert M.
Lehman, George M.
McKibben, Frank P.
Matthes, Francois E.
Mebus, Charles F.
Meredith, Wynne
Millard, Charles S.
Moore, John W.
Moritz, Charles J. H.
Morrow, Jay J.
Neff, Frank H.
Norton, Albert G.
Noyes, Harry L.
O'Brien. Joseph H.
Orr, David, K.
Parker, Frederick Y.
Porter, H. Hobart
Post, William S.
Rankin, Edward Stevens
Reed, Melville E.
Ripley, Theron M.
Robbins, Allan A.
Rowell, George F.
Sanborn, Frank B.
Sargent, Joseph A.
Scharschmidt, Samuel H.
Smith, Leonard C. L.
Smith, Walter M.
Smith, Wilson F.
Snyder, Christopher Henry
Soper, George A.
Steece, Emmet A.
Strehlow, Oscar E.
Tower, J. Wallace
Tresise, Francis J.
Turner, Claude A. P.
Vauclain, Samuel M.
Venable, William M.
Vogleson, John A.
Vredenburgh, Watson
Wason, Leonard C.
Watson, Wilbur J.
Weymouth, Frank E.
White, William Macintire
Whitford, Noble E.
Wiggins, William D.
Williams, Charles P.
Wilson, Winter L.
Woodard, Silas H.

Annual Report of United Engineering Trustees Summarized

THE TWO DEPARTMENTS of United Engineering Trustees, Inc., the Engineering Societies Library and the Engineering Foundation, together with the administrative department (including the Engineering Societies Building) finished their fiscal year ended September 30, 1935, within their alloted budgets.

The value of the assets of the United Engineering Trustees and its departments, as attested by its balance sheet of September 30, 1935, was $3,417,080.32. The balance sheet does not include the value of the Engineering Societies Library, which is appraised at $480,800. The assets are divided as follows:

Real estate	$1,987,793.92
Endowment funds and temporary investments	1,380,754.11
Cash, prepaid insurance, and accounts receivable	48,532.29
Total	$3,417,080.32

The following pertinent excerpts are taken from the 1935 annual report of Harold E. Coes, president:

"The fiscal year of 1935 covered nine months only, from January 1 through September 30. This was the transition period under new by-laws, which changed our year end from December 31 to September 30. In consequence, all acts were based upon an apportioned budget for comparative purposes."

"The Corporation retains its tax-exempt status, having made no departure from its chartered purposes, namely, 'the advancement of the engineering arts and sciences in all their branches, and to maintain a free public engineering library.' "

"The Corporation continues as treasurer for the Professional Engineers Committee on Unemployment and has recently accepted appointment as treasurer for Engineers' Council for Professional Development, thus further serving the profession and its interrelated organizations, and fulfilling the purpose of its creation."

"The national colors of the 342d Engineer Regiment were presented to United Engineering Trustees, Inc., for custody and have been placed in the cabinet dedicated to such purposes, and located at the east end of the entrance lobby of Engineering Societies Building. We are now custodians for the national colors of the 11th, 24th, 27th, and 342d Engineer Regiments, and the regimental colors of the 17th, 24th, and 27th Engineer Regiments and of the 312th Field Batallion, U. S. Signal Corps."

"Under supervision of the Real Estate Committee, important improvements have been made in the public address system in Engineering Auditorium, so that today it represents the ultimate in service to users of the auditorium. The previous equipment has been the target of much criticism."

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Notes on Government Activities

Early arrivals to Congress seem agreed that there must be less spending, better planning of what is spent, and that there must be a shift from government to private employment. Relatively small employment gains have been made outside of government. Millions are still dependent upon government. It is very difficult to get true figures. Industry, it is estimated, has absorbed about a million, and hundreds of thousands have found work in other phases of business. The Bureau of Public Roads reports 5,000,000 man-months employment in the federal highway program for the fiscal year ending June 30, 1935, financed from 1934 and 1935 emergency funds. They state that farm-to-market roads, grade-crossing elimination, and expanded highway construction are progressing at a rate which indicates they may exceed last year's expenditures and also employment.

While there is a general belief that the so-called operating budget for normal government departments will be cut by $500,000,000 it is equally evident that some sort of a clean-up and catch-all appropriation, estimated at from one and a half to three billion dollars, is the President's plans for federal construction, CCC Camps, state relief projects, and a miscellaneous group of federal projects. There is little doubt but what such appropriations will be earmarked by Congress and not be blanket appropriations.

Science Advisory Board Makes Report

The second report of the Science Advisory Board, established by executive order of President Roosevelt in July 1933, under the National Research Council created by Congress at the request of President Wilson in 1918, has just been published. Like the National Resources Committee, it addresses itself to certain problems of national development in which the engineer and scientist have a part. The report of the National Resources Committee which has been transmitted to Council's members in sections as a part of the semi-monthly "embassy service" is related to the broader problems of the planned technical, social, and economic development of our national resources. Like the National Resources Committee, the Science Advisory Board has no authority for action. It may only recommend. Both reports attempt to give broad direction to national policies—the one emphasizing the values of a planned approach to national development, the second concerning itself with the relating of government to effective research and what may be called the "tools" of planning.

The general report of the Science Advisory Board covers such subjects as the national dependence on science, the need for a science advisory service to government, and the future development of a science advisory service. It recommends, first, that a body be set up under the National Academy of Sciences, to succeed the present reporting board, and second, that the responsible government officers and this new board continue to seek the solution of the problems which have been reported upon.

The second part of the report deals with the reorganization and reconsideration of certain of the scientific branches of the government, including the Weather Bureau, the Bureau of Chemistry and Soils, the surveying and mapping services of the federal government, the relation of patents to new industries, and a dozen other reports of inquiries into the purposes and the efficiency of present government undertakings.

Once again the necessity as well as the desirability of a basic mapping program is projected in this report. The scientists and engineers who made this latest recommendation have done so at the request of the Bureau of the Budget. Under the chairmanship of Douglas Johnson, professor of physiography, Columbia University, a committee of seven geographers, geologists, and engineers have presented the results of six months of intensive study of 28 federal agencies engaged in surveying and mapping upon recommendations of the Federal Board of Surveys and Maps. The report, after emphasizing the many values in such a program already well known to members of American Engineering Council, recommends that an agency known as the "United States Coast and Interior Survey" be set up either as (1) an independent establishment reporting to the President, (2) as a unit of the Department of the Interior, or (3) as a unit of the Department of Commerce. The present director of the Coast and Geodetic Survey of the Department of Commerce is proposed as the head. The new agency would comprise the following: (1) The Coast and Geodetic Survey, (2) the Topographic Branch and the Division of Engraving and Printing of the Geological Survey, (3) the International (Canada) Boundary Survey, and (4) the Lake Survey. The Committee recognizes the individuality and purposefulness of many subsidiary mapping services.

The plan, as proposed, in general has the support of all the agencies concerned. It was recommended that the consolidation proposed be brought about by executive order but it is our understanding that the President no longer has this power, so that action rests on congressional consideration.

Thus one more non-partisan and able effort to effect a much desired result calls for a further follow-through plan.

In November the Federal Board of Surveys and Maps requested the American Engineering Council to undertake to coordinate the opinion of map users on the need for the basic mapping program. A proposal for action will be presented at the annual meeting of the Council on January 9, 1936.

Council's Annual Meeting, January 9–11, 1936

"The Engineers' Relations to National Development" and "Economic Status of the Engineer" will be the two major topics of the annual meeting of Council, January 9, 10, and 11. Under these major themes will be grouped the reports of the Council's Committee on Public Affairs and of the special and standing committees of Council. Last year the heads of government agencies, old and new, presented to the delegates the various ways in which the engineering profession could cooperate in the emergency conditions in the vertical fields of government relations to manufacturing (NRA), public works (PWA), relief (FERA), and several other subsidiary subjects. This year, what may be said to be two horizontal slices of government activities will be presented both by representatives of the government and by chairmen of standing and special committees of Council. One of these slices will concern itself with the public values of the engineers' part in national development, such as public and private construction, development of water resources, mapping and surveying, rural electrification, patent legislation, and so forth. The second slice will deal with such questions as the survey of engineers, the merit system, engineers' compensation in government service, government competition with private engineering practice, etc.

Local Societies Cooperating with E.C.P.D. and Council

Local engineering societies have expressed especial interest in developing programs for members on professional and public questions as well as subjects of technology. A number of local sections of the national engineering societies, as well as local independent all-engineer groups, have related themselves to such questions as advising young men as to the values in the engineering profession, the choice of a profession, and also in the post-graduate interests of young men. At the invitation of the Providence Engineering Society, Gen. R. I. Rees, representing the E.C.P.D., and Frederick M. Feiker, of American Engineering Council, met with representatives of this active local organization of engineers to discuss plans for development and coordination. It is hoped that suggestive plans for the furtherance of mutual purposes will result from the friendly and stimulating discussions that took place.

Washington, D.C.
December 10, 1935

Civil Engineering Completes Fifth Full Year

With the previous issue, that for December 1935, Civil Engineering completed its fifth full year of publication. However, since the first issue came out in October 1930, the December issue represents not the sixtieth but the sixty-third number. During this period, over 4,200 pages of editorial matter were published, dealing with every branch of the broad civil engineering profession and describing projects in many foreign countries as well as in all parts of the United States.

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

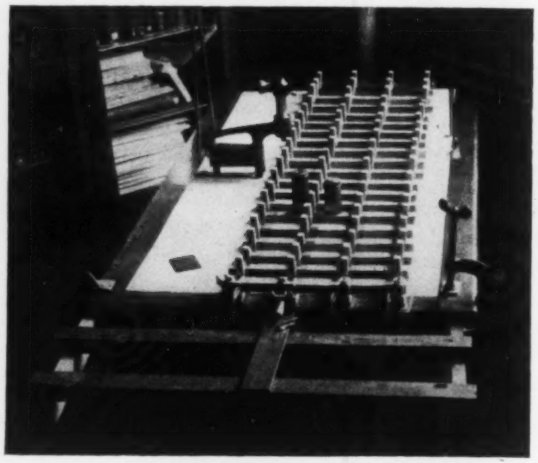
Volume 62 of "Proceedings" begins with the January number, in which will be featured four papers of particular interest to those engaged in the hydraulic, power, irrigation, structural, and construction branches of civil engineering.

TALL BUILDING FRAMES STUDIED BY MEANS OF MECHANICAL MODELS

Small models of tall building frames, composed of steel strips $^3/_4$ in. wide and of varying gage thicknesses, have been used with interesting results in the civil engineering department of the University of Pennsylvania. The findings are now recorded in an article entitled "Tall Building Frames Studied by Means of Mechanical Models," by Francis P. Witmer, M. Am. Soc. C.E., and Harry H. Bonner, Esq., which has been scheduled for the January issue of PROCEEDINGS. Engineers who are concerned with the design of tall buildings, and those engaged in guiding such design should find this paper interesting and valuable. Its scope is confined to the determination of the vertical reactions due to transverse forces acting upon variously proportioned bents of four and six columns, having small connections of a pure bending type, and no diagonal sway braces or knee braces. The arrangement is illustrated by the accompanying photograph.

The paper points out that until quite recently the analysis of building frames of this type subjected to lateral wind forces has generally followed either the portal theory or the cantilever theory, both of which are based upon fundamental assumptions that are not theoretically correct but which yield results that are satisfactory for the design of structures of ordinary proportions. Messrs. Witmer and Bonner discuss the results of their model study in comparison with various modifications of these two theories, as well as with the slope-deflection method (according to W. M. Wilson, F. E. Richart, and Camillo Weiss), the Hardy Cross method of moment distribution, and the method of equal deflections advanced by Henry V. Spurr, M. Am. Soc. C.E. Experiments on the four-column bent constitute the most important part of the paper, and five distinct groups of these four-column bents were tested. In each case the model was $47^1/_2$ in. high in 19 equal stories. The bents differed in the variation in the moments of inertia of girders as between the side span and the center span, and also as to length of span and sizes of columns. On the basis of these studies, it is concluded that (1) increasing the size of either inner or outer columns has relatively less effect upon the reaction ratios than a change in the girder ratio, and that (2) with a wider center bay, the increase in size of the center girder, in order to produce the cantilever relation of reactions, is very much greater than for equal bays, although the latter case requires an increase of about 100 per cent.

An important phase of this paper lies in its attempt to evaluate the relative reliability of the portal theory and the cantilever theory. The natural tendency of both four and six-column bents, in which girders are designed for vertical loads only, is to develop vertical reactions much more nearly in agreement with the portal theory than with the cantilever theory. In order to make an assumption of cantilever distribution of the vertical reactions justifiable, it will generally be necessary to increase the moments of inertia of certain girders by an appreciable percentage. In any case a model should furnish a reasonably close relation between the reactions that will actually be developed. These values might be used as the basis of a rational design. In order to produce results having a maximum degree of reliability, the paper recommends that excessively rigid bents be avoided in the construction of models, the width of the bays in any case being as liberal as is practicable.



MODEL USED BY WITMER AND BONNER IN EXPERIMENTS AT THE UNIVERSITY OF PENNSYLVANIA

MODERN CONCEPTIONS OF THE MECHANICS OF FLUID TURBULENCE

Pioneering in an engineering sense may be visualized by reference to the activities of research workers struggling with questions pertaining to the physical sciences as yet not understood by the practical minded. For the most part, those of us who are occupied by a multitude of everyday problems merely attempt to "follow along" by keeping in touch with the literature in our particular specialties, applying an elementary new phase from time to time as its significance slowly dawns upon us. Many times, the full implication of a new truth, discovered in research, is not made available for practical use for many years after its first definition. Finally someone takes the trouble to interpret the theoretical ideas in a practical light, and what was formerly pure theory then rapidly becomes a body of practical knowledge.

What is true of engineering in general and of civil engineering in particular, is especially true in the field of hydraulic research; and in a paper entitled, "Modern Conceptions of the Mechanics of Fluid Turbulence," Dr. Hunter Rouse, of Columbia University, undertakes to summarize and interpret the more modern scientific methods of approach that have made progress possible toward a solution of the problem of resistance in turbulent flow, with particular emphasis on flow through pipes. After a brief discussion of pipe resistance in terms of general dimensionless parameters he describes qualitatively the mechanism of fluid turbulence. The inner mechanism of flow is then followed from the laminar stage through the critical zone and well up into the region of high Reynolds numbers for both smooth and rough pipe. Finally, Dr. Rouse explains the Prandtl-Kármán theory of the mixing length, the significance of the laminar boundary layer with relation to surface roughness, the latest experiments on artificial roughness, and Dr. von Kármán's universal relationship between the velocity distribution and the resistance to flow, all of which are treated in terms of the foregoing conception of the mechanics of fluid motion.

BEHAVIOR OF STATIONARY WIRE ROPE IN TENSION AND BENDING

In an experimental investigation described under the title, "Behavior of Stationary Wire Rope in Tension and Bending," Douglas M. Stewart, Jun. Am. Soc. C.E., has attempted to find the answer to the question of what stresses are created by bending wire rope around sheaves of various diameters. This is a phase of structural analysis that has wide application and, for a number of years, has been the subject of sharp controversy. The experiments were conducted with a view to appraising the relative merits of the several formulas now being used—from that of Reuleux to those of Carstarphen and Meals.

The experimental test data are presented in the paper in some detail as a basis for defending ten definite conclusions. Mr. Stewart found, for example, that the modulus of elasticity of a rope as a whole was increased about 50 per cent by the first loading, and continued to rise slowly upon further repetition of the load. The coefficient of friction of a regular lay rope on a steel sheave was approximately 0.14 and of a Lang lay rope roughly 0.38. A preformed rope showed less loss of strength in bending over sheaves but also about 5 per cent less in tensile strength and efficiency than a non-preformed rope.

COMPARISON OF SLUICE-GATE DISCHARGE IN MODEL AND PROTOTYPE

Whatever their specialty, nearly all engineers will be interested in the forthcoming paper by F. W. Blaisdell, Jun. Am. Soc. C.E., entitled "Comparison of Sluice-Gate Discharge in Model and Prototype." Whether in the field of hydraulics or in the many other branches of civil engineering, the theoretical consideration underlying tests of small-sized structures by models is of ever-increasing importance. For his full-scale data, Mr. Blaisdell has taken the experiments performed on the Tremont Gates at Lowell, Mass., in June 1868, by the late James B. Francis, Hon. M. Am. Soc. C.E. The full-scale sluices are 9 ft wide by 7.12 ft high to the top of the arch, and each sluice is closed by wooden gates 10 in. thick. The results of Mr. Francis' tests are plotted on logarithmic paper and compared with similar tests on a model of this structure. With a scale ratio of 1 to 15, the base section of the model was constructed of sand, cement and mortar, whereas the top section consisting of the sluices and the gate slots were constructed of cement and white pine sawdust. The gates were of redwood 0.66 in. thick, square-edged, held in place by wedges.

In this paper the aim is to demonstrate that (1) models of sluice gates can be depended upon to predict the discharge of their prototypes with reasonable accuracy; (2) Froude's model law will apply to the discharge of sluice gates; (3) roughness of both model and prototype must be given consideration in the construction of the model; and (4) good results should not be expected for small gate openings and low velocity.

CLOSING DISCUSSIONS

Closing comments on a number of exceedingly interesting papers are expected to be published in the January issue of PROCEEDINGS. These include the following: "Rational Design of Steel Columns," by D. H. Young, Jun. Am. Soc. C.E.; "Elastic Properties of Riveted Connections," by J. Charles Rathbun, M. Am. Soc. C.E.; "The Effect of Secondary Stresses Upon Ultimate Strengths," by John I. Parcel, M. Am. Soc. C.E., and Eldred B. Murer, Jun. Am. Soc. C.E.; and "Underground Corrosion," by K. H. Logan.

Appointments of Society Representatives

Arthur S. Tuttle, President Am. Soc. C.E.; **Harrison P. Eddy** and **Alonzo J. Hammond**, Past-Presidents Am. Soc. C.E.; **Daniel W. Mead**, Hon. M. Am. Soc. C.E.; and **George T. Seabury**, Secretary Am. Soc. C.E., have been appointed Society representatives on the Assembly of American Engineering Council for the coming year.

Ernest M. Van Norden, M. Am. Soc. C.E., has been appointed to represent the Society as a director of the Thomas Alva Edison Foundation.

L. K. Sherman (chairman), **Donald M. Baker**, **M. C. Hinderlider**, **Lawrence M. Lawson**, and **A. D. Weston**, Members Am. Soc. C.E., have been appointed members of a newly organized committee to be known as the Committee on National Water Policy.

News of Local Sections

IOWA SECTION

At the seventeenth annual meeting of the Iowa Section, which was held in Des Moines on November 21, 1935, the following officers were elected for the coming year: R. A. Caughey, president; A. H. Holt, vice-president; R. B. Kittredge, secretary-treasurer; and A. H. Wieters and R. E. Robertson, directors. Brief talks on Student Chapters were given by J. Frank Field, president of the University of Iowa Student Chapter, and Freeman Drew, president of the Iowa State College Student Chapter. The afternoon session was then turned over to a discussion of the aims and activities of the Society, which was led by Theodore A. Leisen, Director of the Society, and Walter E. Jessup, Field Secretary. After a dinner George M. Griffith, assistant acting director of the Public Works Administration for Iowa, spoke on the work of the PWA in that state. The attendance was 50.

KANSAS STATE SECTION

There were 31 present at a meeting of the Kansas State Section held at the Hotel Kansan in Topeka on November 26, 1935. The feature of the occasion was two interesting talks on Society affairs, given by Director Leisen and Field Secretary Jessup. Following the meeting, the Juniors met to discuss the possibility of forming a Junior organization.

LOUISIANA SECTION

The board of directors of the Louisiana Section recently appointed A. J. Negrotto acting treasurer to fill the vacancy caused by the resignation of Alvin Fromherz, who has moved from New Orleans to Birmingham.

MARYLAND SECTION

At a meeting held on Wednesday evening, December 11, 1935, the Maryland Section held its annual election of officers, which resulted as follows: Philip G. Lang, Jr., president; Abel Wolman, vice-president; and C. B. Bryant, secretary-treasurer. During the early part of the evening, members of the Section and their guests assembled in Latrobe Hall at Johns Hopkins University in Baltimore, to hear a most interesting lecture by Commandant C. E. Rosendahl, U. S. Navy, who appeared on this occasion as an advocate of the dirigible or lighter-than-air forms of aerial conveyance. An enthusiastic discussion followed from the floor.

METROPOLITAN SECTION

Air conditioning was the topic discussed at an interesting meeting of the Metropolitan Section held in the Engineering Societies Building in New York City on December 18. A. Warren Canney, field engineer for the Standard Air Conditioning Company of New York, spoke on the aims and accomplishments of air conditioning, and described several of the methods now in use. Building and air conditioning must be partners, he pointed out, if the utmost economy is to be obtained. The design of the air-conditioned system for Rockefeller Center served as the basis for a highly significant forecast of the entirely air-conditioned city of the future. Then A. E. Stacey, Jr., vice-president of the Buensod-Stacey Air Conditioning Company, Inc., added an account of his experience in the manufacture and installation of air conditioning equipment. The meeting was well attended, over 400 members and others being present.

Forsaking technical programs for the holiday season, the Junior Branch of the Metropolitan Section held an informal dinner meeting on December 10. Impromptu one-minute speeches, most of them humorous, by each of the 30 persons in attendance added much to the good fellowship of the occasion.

PHILADELPHIA SECTION

A symposium on the work of army engineers in the field of civil engineering was presented at a joint meeting of the Philadelphia Section and the local chapter of the American Military Engineers held on December 6. There were 77 members and guests present at the dinner and 350 at the meeting following. J. C. H. Lee, Lieutenant-Colonel, Corps of Engineers, Philadelphia District, presided and introduced each speaker. The list of these speakers included R. C. Sutton, chief administrative assistant of the Philadelphia District, who gave a description of current work in progress under the WPA; C. W. Burlin, Captain, Corps of Engineers, who discussed the problems of the army engineers in the Canal Zone; Edward B. Sandelands, chief of the Technical Division of the Philadelphia District, whose topic was the technique of making surveys; F. G. Kohloss, Captain, Corps of Engineers, who spoke on the control of the sea; L. D. Shuman, principal engineer of the Philadelphia District, who described the construction and dredging equipment used on the new deeper channel of the Delaware River from Trenton to the sea; and Howard Ker, Captain, Corps of Engineers, who spoke on the Chesapeake and Delaware Canal.

PORTLAND (ORE.) SECTION

The regular monthly meeting of the Portland (Ore.) Section was called to order by President Griswold at the University Club on November 15. There were 39 present. The technical program was initiated with a talk on the Portland sewage disposal project, given by William Levin, director of the State Hygienic Laboratory. The next speaker was John W. Cunningham, consulting engineer of Portland, who discussed the problems involved in the design of intercepting sewers. Then R. E. Koon, consulting hydraulic and sanitary engineer of Portland, gave a history of Portland's sewage disposal problem, explaining particularly the proposed method of treatment as opposed to methods advocated by others. The final speaker was R. G. Dieck, consulting civil engineer of Portland, who discussed the financial aspects of the problem.

SACRAMENTO SECTION

A series of weekly luncheon meetings has been enjoyed by the Sacramento Section, the average attendance at these gatherings being about 30 members and guests. However, there were 100 present at the annual ladies' day, which was held on October 15. The speaker on this occasion was C. W. Goethe, president of the National Immigration Study Commission and national president of the Eugenics Association, who gave an interesting address on international immigration and eugenics problems. Following luncheon, the ladies were entertained at bridge. Among the speakers at the other sessions was Walter R. Young, supervising engineer of the U. S. Bureau of Reclamation; Irving Ford, Sacramento attorney; M. M. Falk, consulting aeronautical engineer; A. W. Copley, Pacific Coast engineering manager for the Westinghouse Electric and Manufacturing Company; W. A. Smith, of the Division of Highways, California Department of Public Works; and Clarence Kromer and Albert Givan, respectively president and former president of the Section.

SAN DIEGO SECTION

At the November meeting of the San Diego Section the speaker was Lewis B. Lesley, of San Diego State College. Professor Lesley who spent the past summer in Europe, gave an interesting talk on the European situation, dwelling particularly on the current Ethiopian crisis. At the business session there was discussion of the proposed bond issue to make the schools of San Diego earthquake-proof.

ST. LOUIS SECTION

There were 100 present at the annual meeting of the St. Louis Section held at the Congress Hotel on November 23. On this occasion the Section was host to professors of civil engineering and members of Student Chapters at colleges in the vicinity of St. Louis. During the business session the annual election of officers was held, with the following results: S. C. Baker, president; William C. E. Becker, vice-president; R. A. Willis, secretary-treasurer; Joseph E. Vollmar, councillor; and Malcolm Elliott, alternate councillor. J. H. Porter and W. J. Burton were automatically carried over as vice-president and councillor, respectively. The list of speakers included Field Secretary Jessup, who gave a short talk on engineering organizations; Charles M. Talbert, vice-president of the Deuchler-Talbert Company, who spoke on the engineer in other professions; and J. F. Coleman, Past-President of the Society.

TENNESSEE VALLEY SECTION

The new officers for the Tennessee Valley Section are as follows: A. F. Porzelius, president; C. E. McCashin, vice-president from Chattanooga; H. A. Wiersema, vice-president from Knoxville; E. D. Burchard, vice-president from Asheville; Felix Truss, vice-president from Muscle Shoals; and Hal H. Hale, secretary-treasurer.

Student Chapter Notes

UNIVERSITY OF VIRGINIA

Members of the student body and faculty were responsible for the programs presented by the University of Virginia Student Chapter during the past year. In the spring members of the Chapter journeyed to Lexington, Va., where they attended the Student Chapter convention held at the Virginia Military Institute.

VIRGINIA POLYTECHNIC INSTITUTE

The Virginia Polytechnic Institute Student Chapter held 15 meetings in the 1934–1935 school year, with a total attendance of 354. Students, members of the faculty, and outside speakers furnished the technical programs for these sessions. On some occasions motion pictures of current engineering projects and processes were shown.

WASHINGTON UNIVERSITY

The Washington University Student Chapter reports that it has completed one of its most successful years. Eleven meetings held during the year attracted a total attendance of 268, an increase of more than 40 per cent over the attendance during the previous school year. Several interesting outside speakers were heard, the list including R. A. Kirkpatrick, of the Union Pacific Railroad Company; J. C. Pritchard, former director of public utilities of St. Louis; and W. E. Jessup, Field Secretary of the Society. On one occasion a motion picture obtained through the courtesy of the U. S. Bureau of Mines was shown.

WEST VIRGINIA UNIVERSITY

The West Virginia University Student Chapter reports that its enrolment during the 1934–1935 school year was 100 per cent of those eligible for membership. A great number of student papers were presented at the 36 meetings held during the year. The total attendance at the meetings was 900.

WILLIAM CAIN ENGINEERING SOCIETY (UNIVERSITY OF NORTH CAROLINA)

The University of North Carolina Student Chapter (William Cain Engineering Society) reports that its 1934–1935 enrolment was 100 per cent of those eligible for membership. The technical programs, presented at the eight meetings, included the reading of papers by students, members of the faculty, and outside speakers. At other sessions the Society's illustrated lectures were shown. Members of the Chapter participated in carrying out a student-faculty day program and also served as sponsors at the annual engineers' ball.

UNIVERSITY OF WISCONSIN

There were 1,504 in attendance at the 11 meetings held by the University of Wisconsin Student Chapter during the past year. Several interesting motion pictures were shown at some of these sessions. At other meetings talks were given by students and outside speakers, the latter including Walter E. Jessup, Field Secretary of the Society.

WORCESTER POLYTECHNIC INSTITUTE

Prominent on the list of speakers who appeared before the Worcester Polytechnic Institute Student Chapter during the past school year were W. W. Perkins, of the National Paving Brick Association; Lester W. West, consulting civil engineer of Worcester, Mass.; and Maj. Thomas R. Kerchner. In the spring an interesting joint meeting was held with the Worcester Engineering Society, and the last meeting of the year took the form of a banquet.

UNIVERSITY OF WYOMING

Students presented papers at several of the six meetings held by the University of Wyoming Student Chapter during the past school year. A wide range of engineering subjects was treated in these papers, which proved of interest to all. The total attendance at the meetings was 148.

YALE UNIVERSITY

The Yale University Student Chapter reports that its 1934–1935 enrolment was 100 per cent of those eligible for membership. There were seven meetings and a total attendance of 303. Among the outside speakers were Charles E. Smith, vice-president of the New York, New Haven and Hartford Railroad; Caleb M. Saville, manager and chief engineer of the Board of Water Commissioners of Hartford, Conn.; Theodore T. McCrosky, planning director of Yonkers, N.Y.; and Frank A. Barbour, Director of the Society and consulting engineer of Boston, Mass. The Connecticut Section of the Society annually entertains the Chapter, and this year for the first time the Chapter reciprocated by entertaining the Section on the afternoon and evening of December 13.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for February

AMONG THE ARTICLES scheduled for the February issue is one by E. L. Daley, M. Am. Soc. C.E., Colonel, U. S. Corps of Engineers, on canalization of the upper Mississippi. The program now being carried on will provide a channel with a minimum depth of 9 ft, extending from a point near St. Louis to as far north as Minneapolis. This plan, contemplating the construction of 23 locks and dams in addition to those already completed at Minneapolis, Hastings, and Keokuk, involves an expenditure estimated at $150,000,000. A feature of the work is the use of submergible roller gates employing somewhat different sealing principles from gates of this type previously used in Europe. End shields are made large and fall behind the apron rather than in front of it, with consequent advantages.

An interesting account of the Victoria hydro-electric development on the Ontonagon River in northern Michigan, is presented by E. L. Chandler, M. Am. Soc. C.E., now chief engineer of the Chattanooga Flood Protection District. An unusual feature of the Victoria Dam is a concrete section composed of four inclined arches supported by piers on 75-ft centers. As the piers converge slightly downstream, the dam is really an arched multiple-arch structure. Protection against ice thrust, a real problem in the Lake Superior region, is secured by discharging air along the upstream faces of the piers at a point about 10 ft below the surface. Many other evidences of the resourcefulness of the designers and the builders appear in this graphic description of the work.

In another of his interesting historical articles on tall buildings, Robins Fleming tells why they are barred in London, where the code provides that a building other than a church or chapel shall not be erected or increased to a greater height than 80 ft—exclusive of two stories in the roof and of ornamental towers—without the consent of the city council. The "law of ancient lights," held to be the greatest single deterrent to the construction of tall buildings, declares that such diminution of a neighbor's light as amounts to a nuisance shall give him the right either of injunction or of damages against the owner of the new building. While some English writers favor permitting construction of buildings 150 to 200 ft in height in suitable open locations, the weight of opinion still seems to be that any general increase in height would be undesirable.

Two of the papers scheduled for the February number have to do with the Colorado River Aqueduct, now under construction by the Metropolitan Water District of Southern California. The first, by T. W. Osgood, Assoc. M. Am. Soc. C.E., safety engineer, tells how the remarkable safety record for this huge project has been established and maintained. Contributing factors include annual courses in first aid, extreme care in handling and storing explosives, general use of safety primers and modern electrical equipment for blasting, and many other efficient safety devices and practices. The other paper, by Carl H. Heilbron, Jr., and William H. Saylor, assistant and junior engineers, respectively, of the District, describes the general form and use of the invar tape extensometer which has been developed for making quick, accurate measurements. This ingenious device was used to determine the variations in cross-section of a full-sized experimental section of the horseshoe-shaped concrete conduit to be used for a large part of the total aqueduct length.

A Sea-Going Society Pin

FROM CALIFORNIA comes the story of the shark which boasted a Society pin. But instead of displaying it externally he modestly carried it inside his stomach. According to this account, when a shark caught about 1912 off Catalina Island was opened up, a man's vest was found, to which was attached a Society pin. On the back of the pin appeared the name of a certain hydraulic engineer whom it is not now possible to identify. He was employed at that time in and around the San Francisco Bay region and lived in the city of San Francisco. An anxious telephone call was accordingly made to his home, where his wife reported that so far as she knew he was in the Sierras on a mission and was not at sea at all or near it.

Fears persisted about the fate of the absent engineer, but these were set at rest when the supposed victim returned home, no doubt surprised at the concern being evidenced over him. Eventually it developed that some time previously his wife had given away a few of his old clothes to a tramp, evidently without removing the pin. This much is known, but what befell the tramp and how the pin came to be inside the shark are matters for conjecture.

Booklet Issued on Government Contracts

A BOOKLET by Col. O. R. McGuire, entitled "Matters of Procedure Under Government Contracts," has recently been published by the Fidelity and Deposit Company of Maryland. This booklet covers the subjects of bids and bidding, award and performance of contracts, settlement of claims under government contracts, emergency public work contracts, and contracts with government corporations. It may be obtained free of charge by writing to the company's home office in Baltimore, Md.

Reclaiming Land Beneath the Sea

HAVING SHUT OUT the North Sea with a massive dike 20 miles in length, Holland is now rapidly reclaiming some 250,000 acres of land which only a short time ago lay beneath the Zuider Zee. Already the first unit of 50,000 acres is well developed; the greater portion of this acreage is under cultivation; and three villages have been constructed.

Closure of the Zuider Zee was completed in 1933. The dike, 24 ft above mean sea level at its crest, carries an automobile highway and a narrower, separate paved strip for cyclists, with sufficient room left for the future construction of a double-track railroad. Almost 50,000,000 cu yd of material went into its construction.

This dike was considered justifiable in itself, even without the attendant possibility of land reclamation, because by it the salt water of the Zuider Zee would eventually be replaced by a fresh-water reservoir for the purposes of irrigation and municipal water supply. It would also furnish additional protection from the sea for the surrounding lowlands and shorten communication lines between Amsterdam and points to the north and east.

Parts of the first unit of reclaimed land are as much as 16 ft below mean sea level. The entire area included in it was diked off from the Zuider Zee in 1929. By August of the following year the area had been pumped dry, and two months later parts of it were sowed for pasture. As rapidly as the rains leached away the salt, other areas were put under cultivation, and to date 27,000 acres have been developed.

Exploitation during the first few years is being kept under control of the government, to ensure proper development of the land and to protect individual farmers against the hazards incident to all new reclamation projects. As soon as the risks are reduced to reasonable limits, the lands are turned over to private developers. The annual rentals, like those on some of the irrigation projects in the United States, commence at a low figure and increase from year to year; they are also regulated in accordance with the current market value of the crops produced.

The information on which this article is based was furnished by James G. Steese, M. Am. Soc. C.E., who visited the Zuider Zee reclamation project while representing the Society at the Sixteenth International Navigation Congress at Brussels, Belgium, in September 1935. A full set of papers presented at the Congress will be filed with the Society as soon as they are available and will be deposited in the Engineering Societies Library.

Bicentennial of Watt's Birth to Be Celebrated This Month

AN INTERNATIONAL broadcast from the birthplace of James Watt will open the bicentennial celebration of his birth, to be held in Philadelphia and Bethlehem, Penn., January 19–21, 1936. Working models of Newcomen and Watt steam engines, on display at the Franklin Institute in Philadelphia and at Lehigh University in Bethlehem, will be another interesting feature of the program. Meetings, dinners, and a luncheon have also been arranged.

The celebration is under the auspices of Lehigh University, the Franklin Institute of Pennsylvania, the North American Branch of the Newcomen Society of England, and the American Society of Mechanical Engineers.

For many years the American Society of Civil Engineers has had in its possession a marble bust of James Watt. As a contribution to the approaching celebration, and in consideration of Watt's outstanding contributions in the field of mechanical engineering, this bust has been donated, by authority of the Board of Direction, to the American Society of Mechanical Engineers.

Conference on Soil Mechanics to Be Held in June

AN INTERNATIONAL conference on soil mechanics and foundation engineering will be held at Harvard University in Cambridge, Mass., during the week of June 22, 1936, under the chairmanship of Charles Terzaghi, M. Am. Soc. C.E., of Vienna.

The primary purpose of the conference is "to make available the best existing information in these fields and to prepare the ground for better coordination of future work." In order to best fulfil this purpose, no restrictions have been placed on the number of papers that may be contributed. Only a few of the papers will be read at the conference—most of them will be made available to registrants sufficiently in advance for detailed examination. The regular sessions therefore can be given over largely to discussion.

Among the important topics to be considered are testing apparatus and technic, soil properties, stress distribution, settlement of structures, bearing capacity of piles, ground-water movement, methods of improving the physical properties of soils, and modern methods of design and construction of foundations. Additional information in regard to registration and to the proper form for submitting contributions can be obtained from Arthur Casagrande, secretary of the committee on organization of the conference, at Harvard University, Cambridge, Mass.

New Standards Announced by Three Organizations

TENTATIVE DEFINITIONS of terms relating to sewer pipe were recently published by the American Society for Testing Materials and are now open for comment and criticism by any interested party. When finally adopted, they will supersede the present standard definitions on the same subject (C8–24) in the 1933 *Book of A. S. T. M. Standards*.

The American Society of Photogrammetry has issued standard specifications for aerial photography and for aerial photographs for stereoscopic plotting of contour maps. This standardization is especially timely in view of the proposal contained in the National Mapping Plan of the Board of Surveys and Maps for the mapping of some 2,000,000 sq miles by aerial methods.

Approval of the following standards of interest to civil engineers has been announced by the American Standards Association:

Graphical Symbols (Z14f)
Manual of Uniform Traffic Control Devices for Streets and Highways (D6)
Colors and Finishes for Cast Stone (CS53)

Five-Year Highway Safety Campaign Announced

A FIVE-YEAR, country-wide campaign to reduce motor-vehicle deaths at least 35 per cent by the end of 1940, looking toward the saving of at least 38,000 lives, begins January 1, 1936, according to a recent announcement of the National Safety Council. Certain states and cities during recent years have clearly demonstrated that such an achievement is possible. Twenty-three states have reported fewer deaths for the first nine months of 1935 than for the corresponding period of last year, including Rhode Island, with a 31 per cent decrease; Oregon, 16 per cent; Massachusetts, 14 per cent; and Minnesota, with an 11 per cent reduction. Likewise, many cities and towns, through intelligent efforts, realized large reductions in 1935.

The time is particularly propitious, since the 1935 toll of death and injury promises to approximate the tragic experience of 1934, when 36,000 people were killed and a million and a quarter others injured—of whom 150,000 will be crippled for the rest of their days. The adoption of uniform laws, including standard drivers' license legislation, will be urged, together with adequate administration of traffic laws, including state highway patrols. The standardization of accident reports will also be undertaken, as well as provisions for more complete accident statistics and their interpretation and application. The detailed engineering, enforcement, and educational technic of the states and cities now doing outstanding work will be made available to the country at large as one of the initial steps in the large program.

Traffic engineering or traffic planning uses facts as its basis instead of guesses or opinions. These facts comprise, in part, accident records showing the number of persons killed and injured, the location of the accident, the actions of the vehicles and pedestrians involved, and pertinent facts about the condition of the vehicles, weather, and road surface. The discouraging failure of much traffic work in this country, as pointed out by the National Safety Council, has been due chiefly to disregard of the need for such facts.

Standards Association Asks Advice on Symbols

A NEW DICTIONARY of letter symbols and abbreviations, the "language" of engineers and scientists, is to be undertaken by a committee of the American Standards Association. Rapid coinage of new words and terms, and the adoption of many foreign words and phrases in the various fields of engineering and the sciences, demands a new compilation of standard usage, according to the committee.

In spite of their many ramifications, engineering and science are becoming more and more integrated and those working in one field find that lack of abbreviations, or confusion in their use, retards progress.

The Committee on Symbols and Abbreviations of the American Standards Association has been reorganized and will begin at once the intricate task of coordinating existing abbreviations and symbols and rewriting the present standards into a comprehensive manual of letter symbols and abbreviations. Its scope is defined precisely as follows: "Standardization of letter symbols and signs for equations and formulas; and abbreviations for use in publications." Because of the difficulty involved in writing this universal simplified language for all phases of engineering, it seems especially important at this stage that the ideas of every interested group be incorporated. It is urgent, therefore, that those interested send comments on the standards that have already been approved and suggestions for useful new symbols and abbreviations not now included, to Dr. J. Franklin Meyer, National Bureau of Standards, Washington, D.C., chairman of the committee. Any organization that has published its own standard for symbols is urged to submit a copy for consideration and for possible coordination with the broader standard.

Twelve standards for letter symbols, abbreviations, and graphical symbols have been developed by the technical committee of the American Standards Association, which has been at work for many years. Recently, in order to simplify its work, this committee was divided into two parts, one covering the letter symbols and abbreviations, and the other the graphical symbols.

The committee on letter symbols and abbreviations, now beginning its work, has 12 subcommittees covering the following broad subjects: Symbols and signs for mathematics; symbols for physics and mechanics, structural analysis, hydraulics, heat and thermodynamics, photometry and illumination, aeronautics, electric and magnetic quantities, radio, astronomy and surveying, and geodesy; and abbreviations for scientific and engineering terms.

The committee that will prepare standards on graphical symbols will start work soon and will also request comments and suggestions on its phase of the problem.

Ellsworth, Member of the Society, Lost in Antarctic

Considerable anxiety is felt for the safety of Lincoln Ellsworth, Assoc. M. Am. Soc. C.E., unreported since a few hours after his take-off several weeks ago on an exploratory flight in the Antarctic. The original plan of Mr. Ellsworth was to make a landing at Little America, hundreds of miles from his starting point, and there await the arrival of his supply ship. If all had gone well, however, he should have been able to maintain constant radio communication with his base. It is of course quite possible that he has arrived safely and that his failure to establish contact is due to a breakdown of the radio apparatus.

Mr. Ellsworth entered the Society as a Junior in 1908 and became an Associate member three years later. The experience record he submitted in 1911 suggests an already deeply rooted interest in exploration. He had served as an assistant engineer on claim surveys at Nome, Alaska; had prospected for copper in British Columbia and searched for hard wood in the forests of southern Mexico; and when he submitted the record was with the Yale Expedition to Peru, engaged in making a cross section of the Andes along the 74th meridian.

Mr. Ellsworth's present expedition was planned long and carefully, and has already made valuable contributions to man's knowledge of the "bottom of the world."

Wise and Otherwise

Professor Abner Abercrombie, specialist in problems, has consented to contribute an occasional brain-twister to the columns of Civil Engineering. When last seen, he was at work upon the following alphabetical puzzle:

```
RUA)CCYAL(DAS
    IHC
    ___
     YIRA
     YAYL
     ____
       RYCL
       RYCL
       ____
```

In the problem, each letter represents a numeral, and when arranged in order from 0 to 9 the letters have engineering significance. Suggestions for other problems, accompanied by solutions, should be addressed to the Editor.

Brief Notes from Here and There

Spigots for ice-cold beer as well as for hot and cold water have been installed in the new building of the Danish Society of Civil Engineers at Copenhagen, according to a recent report in the press. It would seem that our Danish friends are exceeding even the American penchant for innovations.

* * * *

Thousands of acres of fertile land in many parts of the United States would be almost valueless without underdrainage. The first tile to be laid in this country for this purpose was imported from Scotland and put down 100 years ago by John Johnston, a farmer near Geneva, N.Y. It is still functioning. The centenary was commemorated by the American Society of Agricultural Engineers in the erection of a bronze tablet honoring Mr. Johnston as "an outstanding contributor to human welfare."

FARM AND RESIDENCE
—OF—
JOHN JOHNSTON
1791—1880
EMINENT FARMER WHO
HERE ORIGINATED
TILE UNDERDRAINAGE
IN AMERICA IN 1835
AND THEREBY BECAME AN
OUTSTANDING CONTRIBUTOR
TO HUMAN WELFARE
HONORED BY
THE AMERICAN SOCIETY OF
AGRICULTURAL ENGINEERS
1935
ERECTED BY
STATE EDUCATION DEPARTMENT

Tablet Commemorating the First Tile Drainage Project in the United States

* * * *

Married when a freshman, Michael Baker, now president of the Student Chapter at Pennsylvania State College, has added approximately $1,000 to the family exchequer through sales of a 16-page illustrated booklet that he prepared describing the history and principal features of the Pymatuning project. More than 8,000 visitors to this combination water-supply, flood-control, and recreational development have purchased copies. Mr. Baker has somehow found time, also, for enough study to win membership in two honorary fraternities.

* * * *

A number of buildings, bridge piers, and similar structures rise and fall with the tides or with changing ground-water level—for example, buildings in London along the Thames, and the piers of the Waterloo Bridge. In many of these cases, according to Professor Casagrande of Harvard, the structures rest on a thick stratum of homogeneous clay which would require many years for volume changes to take place. The cause of such movements resides in the fact that when the load on the clay adjacent to a structure is increased by a rising water level, the stress in the clay beneath the structure decreases, and vice versa. As a consequence, the clay undergoes elastic deformations at constant volume. One might compare such a phenomenon with the movement of a simple balance: when one side goes down, the other side must rise.

* * * *

In translating into Rumanian the report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, Em. Herscovici of Bucharest has given a fine example of disinterested scientific endeavor. The work was done without recompense, and was complicated by the fact that there are no English-Rumanian technical dictionaries. Until the new translation appeared, Rumanian engineers had worked solely with German specifications.

NEWS OF ENGINEERS

From Correspondence and Society Files

Walker R. Young, construction engineer for the U. S. Bureau of Reclamation, has been appointed engineer in charge of the Bureau's Central Valley project in California, for which an allotment of $20,000,000 has been made.

Theodore B. Parker, formerly project engineer for the Stone and Webster Engineering Corporation of Boston, is now supervising construction engineer for the Tennessee Valley Authority, with headquarters in Knoxville, Tenn.

Joseph Sorkin has resigned his position as senior bridge designer with the Montana State Highway Commission to accept an appointment as structural and hydraulic designer with the Central Nebraska Public Power and Irrigation District. His office will be in Hastings, Nebr.

John C. Thompson, formerly assistant engineer for the Middle Rio Grande Conservancy District, at Chama, N.Mex., has accepted a temporary appointment as assistant engineer with the U. S. Bureau of Reclamation, assigned as office engineer on the Hamilton Dam. His headquarters are at Buchanan Dam, Tex.

Ferdinand G. Gramatky is now connected with the U. S. Engineer Office of the War Department in the capacity of project engineer on the Kenter Canyon Project, Los Angeles, Calif. He was previously engineer on construction for the Jahn and Bressi Construction Company, Inc., of the same city.

William H. Crawford has taken a position as appraisal engineer for the Public Service Commission of West Virginia, with headquarters in Charleston, W.Va.

L. H. Dodd has accepted a position as district engineer for the American Institute of Steel Construction, with headquarters in Dallas, Tex.

P. S. Park is now assistant safety engineer for the Works Progress Administration at San Antonio. He was formerly assistant construction engineer for the State Highway Department at Austin.

T. Keith Legaré, of Columbia, S. C., has resigned as chief labor inspector of the South Carolina State Highway Department to accept an appointment as resident engineer inspector with the Federal Emergency Administration of Public Works.

Richard D. Field, formerly a bridge designer in the New Hampshire State Highway Department, is now an engineer examiner for the National Power Policy Committee on the Passamaquoddy tidal project. His headquarters are in Eastport, Me.

Clarence E. Boesch, who is in the Engineer Office of the U. S. War Department, is now assistant to the district engineer at Ocala, Fla., where he is in charge of the engineering division on the construction of the Atlantic–Gulf ship canal project. He was previously principal engineer in the Memphis office.

L. J. Schnell is now with the Works Progress Administration in the capacity of resident engineer of Albany, Ga. He was formerly with the U. S. Coast and Geodetic Survey.

Merrill S. Bernard has taken a position as hydraulic engineer in the Soil Conservation Service of the U. S. Dept. of Agriculture. His headquarters are in Washington, D.C.

Gene B. Heywood, formerly with Young, Clark, and Company, of Los Angeles, Calif., has become vice-president of Harris, Hall, and Company, of Chicago, Ill.

Elwin S. Warner is now associate highway engineer of the U. S. Bureau of Public Roads, with headquarters in Columbus, Ohio.

DECEASED

William Goodson Ames (M. '13), prominent in the sugar industry in Cuba and Florida, died in Tucson, Ariz., on November 24, 1935, at the age of 62. He was born in White Mills, Ky., and graduated from Vanderbilt University. Following his services in connection with the construction of the first subway in New York City, he joined the construction staff of the Cuba Railway. Later he helped form the Havana engineering firm of Smith and Ames. Over a fifteen-year period this organization designed and built many large Cuban sugar properties.

Robert Fulton Cowles (M. '29) died at the Veteran's Home in Yountville, Calif., on November 26, 1935, at the age of 47. During his engineering career he served as supervising engineer for the U. S. Coast and Geodetic Survey, assistant hydraulic engineer for the state of California, and hydraulic engineer for the city of San Diego. He also was employed by J. B. Lippincott, consulting hydraulic engineer of Los Angeles, for six years, and filled a number of other engagements.

Frank William Flittner (M. '33), associate construction engineer, U. S. Bureau of Public Roads, died in Phoenix, Ariz., on October 26, 1935. He was born in Visalia, Calif., on August 14, 1893, and received his engineering degree from the University of San Francisco in 1916. During the War he served in France as second-lieutenant, 4th Engineers, and was wounded at Ypres in August 1918. Following his discharge from the army, he was employed in an engineering capacity by the Standard Oil Company and the Hawaiian Sugar Refining Corporation. He joined the staff of the U. S. Bureau of Public Roads in 1931.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Laurence Hussey (M. '26), engineer for the Palos Verdes Water Company of Palos Verdes Estates, Calif., died on September 25, 1935, at the age of 51. He was born in Boston, Mass. His engineering career was varied, including railroad, topographic, road construction, and drainage work. From 1911 to 1915 he was employed by the San Diego Exposition Company, being general engineering assistant on all construction work pertaining to the fair. In 1922 he became associated with the Palos Verdes project where he was in full charge of all engineering design, office, and field work.

Edward Sherman Jackson (M. '13), bridge inspector for the Montana State Highway Commission, died at Great Falls, Mont., on April 4, 1935, at the age of 66. He was born in Walden, Vt., and graduated from the University of Vermont in 1890, with the degree of C.E. He was identified with many construction enterprises in the West, having been in the employ of the Chicago, Burlington and Quincy Railway (lines west of Missouri) for sixteen years. Later he was with the Barber Lumber Company of Boise, Idaho, and with the Idaho Southern Railroad.

Irving Patterson Kane (M. '28), engineer of treatment plant design, Sanitary District of Chicago, died in that city on November 20, 1935. He was born in Baltimore, Md., in 1886, and was graduated from Massachusetts Institute of Technology in 1910, with the degree of B.S. in sanitary engineering. He was employed by the Baltimore Sewerage Commission and the International Joint Commission. During the War he served in the U. S. Army, attaining the rank of major. After 1919 he was associated with the Sanitary District of Chicago, engaged in treatment plant design.

Walter Richard Ketels (Assoc. M. '30), resident engineer in the Bridge Division of the New Jersey State Highway Department, died on October 24, 1935, at the age of 48. He was born in Brooklyn, N.Y., and devoted the early years of his career to railroad and highway work in the vicinity of New York. In 1922 he joined the staff of the New Jersey State Highway Department, becoming resident engineer a year later in charge of field work on the construction of a number of steel and concrete highway bridges.

John William Musham (M. '14), chief engineer for the Mid-Continent Construction Company of Chicago, Ill., died on December 7, 1935, at the age of 57. He was born in Chicago and graduated from the University of Illinois in 1898, with the degree of B.S. in C.E. He was connected with many Chicago engineering developments, having been employed principally with consulting engineers and contractors in the design and construction of buildings and bridges.

Francis Everett Pratt (M. '11), an engineer specializing in the design of docks and water-works structures, died in Hollidaysburg, Pa., on December 10, 1935, at the age of 63. He had attended Lehigh University and was graduated from Cornell University as a civil engineer. For fourteen years he was chief engineer for Arbuckle Brothers, of Brooklyn, N.Y. Later he organized the contracting firm of Pratt and Moore, builders of bridges, sewers, and roads. For the past fifteen years he was an engineer for the Dexter-Carpenter Coal Company.

Harry Linden Shaner (M. '25), commissioner of public works of Winston-Salem, N.C., died in that city on November 20, 1935, at the age of 56. He was graduated from Virginia Military Institute in 1899, and in the same year became assistant city engineer of Lynchburg, Va. In 1904 he was promoted to the position of city engineer, serving in this capacity until 1918 when he took up his duties at Winston-Salem.

Fenwick Milford Thebo (M. '16), consulting engineer of Alameda, Calif., died in that city on October 25, 1935, at the age of 58. He was born at Fort Edward, N.Y., and attended Union College at Schenectady. His engineering career included experience with the Columbia Improvement Company, the Seattle-Everett Interurban Railway, the Pacific Light and Power Corporation of Los Angeles, the Phoenix Construction Company of New York City, and numerous other organizations, for which he engaged in the design and construction of railways, dams, reservoirs, pipelines, and hydro-electric developments.

George Stevenson Yates (M. '19), with the Cleveland Iron and Steel Works, of London, died in that city on November 1, 1935, at the age of 58. He was born in Edinburgh, Scotland, and graduated in engineering from the University of Edinburgh in 1899. After three years as draftsman and designer in Scotland, he went to England, where he devoted himself to the design of bridges and steelwork. For a considerable time he served as chief engineer of Redpath, Brown and Company, construction engineers of London.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From November 10 to December 9, 1935, Inclusive

ADDITIONS TO MEMBERSHIP

BAFFA, JOHN JOSEPH (Jun. '35), 9824 Fourth Ave., Brooklyn, N.Y.

BAKER, ROBERT CLINTON (Assoc. M. '35), Asst. Director and Chf. Engr., WPA, Dist. 2, Box 2791, Tucson, Ariz.

BATES, FRANCIS, JR. (Jun. '35), Instrumentman, Met. Water Dist. of Southern California (Res., 973 Keniston Ave.), Los Angeles, Calif.

BEAUPAIN, WILLIAM EMERSON (Jun. '35), Highland Ave., South Norwalk, Conn.

BELFORD, HUGH BRICE (Assoc. M. '35), 1940 Holmes Ave., Springfield, Ill.

BENSON, FRED JACOB (Jun. '35), Care, Civ. Eng. Dept., Agri. and Mech. Coll. of Texas, College Station, Tex.

BLASER, JAMES ARNOLD (Jun. '35), 1615 Twenty-Eighth St., Rock Island, Ill.

BRANDS, MAURICE DWANE (Jun. '35), 3804 North, East Davis St., Portland, Ore.

BRUMBAUGH, JOHN ERNEST (Jun. '35), Asst. Engr. of Larchmont, City Hall (Res., 20 Munroe Ave.), Larchmont, N.Y.

BURT, GORDON LANSING (Jun. '35), Rodman, C.M. St. P. & P. R.R. (Res., 304 Bowen St.), Savanna, Ill.

BUTLER, EARLE BENNETT (Jun. '35), Under Eng. Aide, Hydr. Laboratory, TVA, Norris, Tenn.

CAMBELL, CHESTER WENDELL (Assoc. M. '35), Examining Engr., PWA; 33–28 Eighty-First St., Jackson Heights, N.Y.

CAMPBELL, THOMAS COLIN (Assoc. M. '35), Vice-Pres., Fred F. French Management Co., Inc., 5 Prospect Pl., Tudor City, New York, N.Y.

CORSER, CHAMP ELKINS (Jun. '35), 7006 Twenty-Fourth St., N.E., Seattle, Wash.

CRITES, EVERETT CLAY (Assoc. M. '35), Field Engr., Portland Cement Assoc., Lincoln (Res., 915 East 3d St., North Platte), Nebr.

CROWLEY, JOHN BERNARD (Jun. '35), Draftsman-Squad Leader, Gibbs & Hill, Inc. (Res., 536 West 152d St.), New York, N.Y.

CSANYI, LAIDS HENRY (Assoc. M. '35), Eng. Asst., Div. of Design, Dept. of Public Works of Manhattan, New York (Res., 150–03 Eighty-Eighth Ave., Jamaica), N.Y.

DE JULIO, FREDERICK JOHN (Jun. '35), 993 Rogers Ave., Brooklyn, N.Y.

DEMBOSKI, HENRY (Jun '35), Care, TVA, Gen. Eng. Div., Knoxville, Tenn.

DODSON, VIRGIL IVAN (Jun. '35), R.F.D. 1, Newark Valley, N.Y.

DOWNING, FRANCIS JOHN (M. '35), 103 Crescent St., Buffalo, N.Y.

DUNNING, ABRAM BEEMER (M. '35), Engr.-Examiner, PWA, 20 Commerce St., Montgomery, Ala.

ENKEBOLL, WILLIAM (Jun. '35), 1605 East 47th St., Seattle, Wash.

FELTEN, WILHELM BERNHARD REINHARD (Jun. '35), Care, Wilson, 48–55 Two Hundred and Sixth St., Bayside, N.Y.

FERVER, GREER WILSON (Jun. '35), 251 South Barnard St., State College, Pa.

FLEBUS, CARLO GIUSEPPE (Assoc. M. '35), 412 Fourth Ave., Brooklyn, N.Y.

FORSYTH, BENJAMIN (Jun. '35), 2028 Sixty-Ninth St., Brooklyn, N.Y.

FRITZINGER, GEORGE FRANK (Jun. '35), Engr. and Estimator, Beder Wood's Sons, Moline (Res., 9705 West Main St., Belleville), Ill.

FROST, GEORGE WALKER (Jun. '35), 2 Evergreen Lane, Haddonfield, N.J.

GATTMANN, REED (Jun. '35), 859 Tremaine Ave., Los Angeles, Calif.

GILL, SAMUEL CHRISWELL, JR. (Jun. '35), Perry, Mo.

GRAVES, JOSEPH WHITAKER, JR. (Jun. '35), 1217 Clara Ave., St. Louis, Mo.

GREBNER, RONALD GEORGE (Jun. '35), Junior Asst. Draftsman, State Highway Comm. (Res., 935 Western Ave.), Topeka, Kans.

HAINES, REUBEN MATTER (Jun. '35), Eastport, Me.

HALL, PAUL (Jun. '35), With Austin Bridge Co. (Res., 2923 Holmes St.), Dallas, Tex.

HAMLIN, ERNEST JOHN (M. '35), City Engr., Box 1049, Johannesburg, Union of South Africa.

HASELWOOD, ROBERT WALTER (Jun. '35), Morris D 23, Soldiers Field, Boston, Mass.

HAUGHWOUT, FREDERICK EUGENE (Assoc. M. '35), 6 Palmer Ave., Port Richmond, N.Y.

HEGGE, FRITDJOV DORAN (Jun. '35), 3805 Bagley Ave., Seattle, Wash.

HINTON, HOWARD MAYFIELD (Jun. '35), With Photogrammetric Section, S C S (Res., 1744 P St., N. W.), Washington, D.C.

HOPPS, JOHN PHILIP (Jun. '35), Winding Way, Ross, Calif.

HOYEM, CARL HAAKON (Jun. '35), Dist. Engr., FERA, Box 711, Minot, N.Dak.

HUMMEL, JOHN LUCIEN (Assoc. M. '35), Dist. Superv. Engr., U. S. Coast and Geodetic Survey, Box 38, Albany, Ga.

IPPEN, ARTHUR THOMAS (Jun. '35), Teaching Fellow and Asst. in Hydraulics, Mech. Eng. Dept., California Inst. of Technology, Pasadena, Calif.

TOTAL MEMBERSHIP AS OF DECEMBER 9, 1935

Members	5,723
Associate Members	6,119
Corporate Members	11,842
Honorary Members	21
Juniors	3,067
Affiliates	95
Fellows	2
Total	15,027

JOHNSTON, CLAIR CRAWFORD (Assoc. M. '35), Director, Civ. Eng., Univ. of Detroit, Livernois Ave. and McNichols Rd., Detroit, Mich.

JORGENSEN, HOMER WILLIAM (Jun. '35), 1020 West 8th St., Los Angeles, Calif.

KELLER, FRANK, JR. (Jun. '35), 1023 North Tyndall Ave., Tucson, Ariz.

KELLY, EDMONDE BERNARD (Jun. '35), Insp. of Track, Track Div., Board of Transportation, 250 Hudson St. (Res., 718 West 178th St.), New York, N.Y.

KIMBALL, JACK HAVEN (Jun. '35), San. Engr., Palo Alto Sewage Treatment Plant, Palo Alto (Res., 120 Lorton Ave., Burlingame), Calif.

KOCHMAN, EMIL JOSEPH, JR. (Jun. '35), Eng. Asst., Grade 3, to Boro Pres. of Manhattan, Dept. of Public Works, Bureau of Eng., Div. of Design, Room 2100, Municipal Bldg. (Res., 438 East 70th St.), New York, N.Y.

KOMORA, ANDREW MITCHELL (Assoc. M. '35), Office Engr., Norris Dam, For TVA, Box 172, Norris, Tenn.

KREUTZIGER, CARL HENRY (Assoc. M. '35), With Spooner & Merrill, Inc., 20 North Wacker Drive, Room 1506, Chicago, Ill.

LAFLIN, WILLIAM ALAN (Assoc. M. '35), Hydr. Engr., El Paso County Water Dist. No. 1 and Elephant Butte Irrig. Dist.; 318 South Cedar St., Albuquerque, N.Mex.

LANGMUS, GEORGE WILLIAM (Jun. '35), 471 South New St., Bethlehem, Pa.

LEWIN, JOSEPH DAVID (Jun. '35), 500 Bedford Ave., Brooklyn, N.Y.

LISCHER, ALAN ARTHUR (Jun. '35), With Eng. Constr. Corporation, 717 Alby St., Alton, Ill.

McCARTHY, JOHN FRANCIS (Jun. '35), 1039 Seventy-First St., Brooklyn, N.Y.

McDILL, WILLIAM HOWARD (Jun. '35), With Midwest Pre Cote Co., 908 West 25th St., Kansas City, Mo.

McFARLAND, KIRK (M. '35), Pres., Hobson McFarland Tractor Co., 2131 Washington St., Kansas City, Mo.

McGAW, ALEX JAMES (Jun. '35), Instr. Civ. Eng., Univ. of Wyoming, Laramie, Wyo.

McGRATH, RAYMUND VINCENT (Jun. '35), Mass. Inst. of Tech. Dormitories, Cambridge, Mass.

McKIM, ROBERT DAN (Jun. '35), Designer, Black & Veatch, 4706 Broadway, Kansas City, Mo.

MAKELA, GEORGE ALLAN (Jun. '35), 44 Prichard St., Fitchburg, Mass.

MALCHOW, CARTER DANA (Jun. '35), Instrumentman, State Highway Dept., Route 1, Longmont, Colo.

MANDRY, JAMES ELMER (Jun. '35), Junior Engr., Div. of Canal Designing, U. S. Bureau of Reclamation, Customhouse, Denver, Colo.

MARTIN, JAMES ALLAN (Jun. '35), 21 North Salisbury St., West Lafayette, Ind.

METZGER, GEORGE RAYMOND, JR. (Jun. '35), Care, Metzger Constr. Corporation, 429 Carlton St., Buffalo, N.Y.

Moat, Harry Ernest (Jun. '35), 564 Gibson Ave., Kingston, Pa.

Nelson, Arthur Maurice (Jun. '35), Asst. Res. Engr., Minneapolis–St. Paul San. Dist, (Res., 3633 Oliver Ave., North), Minneapolis, Minn.

Netzer, Bennie Nathan (Jun. '35), 2521 Sarah St., South Side, Pittsburgh, Pa.

Ongerth, Henry Joseph (Jun. '35), Rice Check Engr., U. S. Dept. of Agriculture, 2525 Durant Ave., Berkeley, Calif.

Owens, Thomas Milton (Jun. '35), 1551 East 31st St., Brooklyn, N.Y.

Pettersen, Peder Gjerdt (Assoc. M. '35), Res. Engr. Insp., PWA, in Kansas and Oklahoma, 11 West Drummond, Shawnee, Okla.

Phillips, George William (Assoc. M. '35), 707 South 4th St., Tucumcari, N.Mex.

Poore, George Bentley (M. '35), Vice-Pres., Calaveras Cement Co., 315 Montgomery St., San Francisco, Calif.

Pugsley, Edmond Brewster (Jun. '35), Bldg. 233, NAS, Pensacola, Fla.

Reams, Sanford Newton (Jun. '35), Asst. Engr., RA, Div. 3, Chillicothe, Ohio.

Redon, Alexander Louis (Jun. '35), Insp. of Dredging, U. S. Engrs., Dredging Area, 2d New Orleans Dist. (Res., 2667 Le Page St.), New Orleans, La.

Regnier, Raymond Cobington, Jr. (Jun. '35), 4416 Reisterstown Rd., Baltimore, Md.

Reyholec, Otto Frank (Jun. '35), 11 General Heath Ave., White Plains, N.Y.

Rosov, Ivan Alex (M. '35), Designer, D. L. & W. R. R. (Res., 620 West 152d St., Apartment 1), New York, N.Y.

Sandusky, John William (Jun. '35), Care, U. S Bureau of Reclamation, Eng. Dept., Coulee Dam, Wash.

Sastre, Miguel Angel (Jun. '35), Care, Sucesion J. Serrallés, Ponce, Puerto Rico.

Saxe, Louis Steiner (Jun. '35), Eng. Asst., Westchester Lighting Co. (Res., 266 North Fulton Ave.), Mount Vernon, N.Y.

Schnell, Lucius Johnson (Assoc. M. '35), Res. Engr., WPA of Georgia, Dist. 8, 200$^1/_2$ Broad Ave., Albany, Ga.

Schwartzenhauer, Arthur George (Jun. '35), 934 West 6th St., Moscow, Idaho.

Sheridan, Robert Roe (Jun. '35), Asst. Engr., Eastman Kodak Co., Kodak Park (Res., 124 Clay Ave.), Rochester, N.Y.

Sloat, James Walter (Jun. '35), 2635 North East 40th Ave., Portland, Ore.

Smith, Franklin Edward (Jun. '35), Malad, Idaho.

Smith, Sidney Wilson (Jun. '35), 1819 Shuey Ave., Walnut Creek, Calif.

Smith, Travis Logan, III (Jun. '35), Asst. County Engr., Liberty County, Box 416, Liberty, Tex.

Smith, William Andrew, Jr. (Jun. '35), Student Engr. in Highways, Div. of Management, U. S. Bureau of Public Roads (Res., 1312 E St., N.E.), Washington, D.C.

Stern, Richard Morris (Jun. '35), With Joseph T. Ryerson & Son (Res., 1400 East 53d St.), Chicago, Ill.

Stuter, Emil (Jun. '35), SCS-T-21, Brownwood, Tex.

Swartz, Gus. Joseph (Jun. '35), Engr. Draftsman, U. S. Dept. of Agriculture, Bureau of Agri. Eng., 1429 Ninth St., South, Fargo, N.Dak.

Swartz, Robert Walter (Jun. '35), 497 Neptune Ave., Brooklyn, N.Y.

Swinney, Leonard Robert (Jun. '35), Box 986, Baton Rouge, La.

Tennant, William Walton (Assoc. M. '35), Head, Coordination Div., Standard Oil Co. of Louisiana (Res., 520 Convention St.), Baton Rouge, La.

Tomb, Charles Emerson (Jun. '35), Landis St., Coopersburg, Pa.

Tonetti, Frederick Charles (Jun. '35), 1444 Thirtieth Ave., Long Island City, N.Y.

Turner, Herbert Nolan (Jun. '35), Engr., State Park 19, Wilburton, Okla.

Vargas, Joseph Anthony, Jr. (Jun. '35), Mystic Rd., Stonington, Conn.

Waananen, Arvi Olavi (Jun. '35), 351 North State St., West Concord, N.H.

Wagner, Raymond Francis (Jun. '35), 28 Gorham St., Cambridge, Mass.

Watters, Frank Fairchild (Jun. '35), Under Eng. Aide, TVA, 501 Union Bldg., Knoxville, Tenn.

Weathers, Harold Clinton (Jun. '35), Hydrographic Draftsman, War Dept., Corps of Engrs., U.S.A., Q-14, New Basin Canal, West End Boulevard, New Orleans, La.

Weggel, Harold Arthur (Jun. '35), Field Engr., Consumers Power Co.; 211 North Sheridan St., Bay City, Mich.

Weiner, Jesse (Jun. '35), Laboratory Asst. and Material Insp., State Highway Testing Laboratory (Res., 2319 Green St.), Columbia, S.C.

White, Kenneth Philip (Jun. '35), 516 McCallie Ave., Chattanooga, Tenn.

Wiskocil, Clement Tehle (M. '35), Associate Prof., Civ. Eng., Univ. of California, 216 Eng. Bldg., Univ. of California, Berkeley, Calif.

Woelke, Walter Julius (Jun. '35), Bridge Foreman, Hyde Const. Co., Cherokee (Res., 901 West Randolph, Enid), Okla.

Young, David Milson (Jun. '35), With Eng. Dept., Utah Power and Light Co. (Res., 759 Jeppson Ave.), Salt Lake City, Utah.

Young, Lewis Alaric (Jun. '35), Engr., Charles A. Haskins (Res., 505 West 31st St., Apartment 10), Kansas City, Mo.

Ziobro, Stanley Joseph (Jun. '35), Under Eng. Aide, Gen. Eng. Div., Eng. Design Section, TVA, 1501 West Clinch Ave., Knoxville, Tenn.

Membership Transfers

Aloff, Abraham Martin (Jun. '32; Assoc. M. '35), Examiner, Div. of Civ. Service, Commonwealth of Massachusetts, Room 152, State House, Boston, Mass.

Baylor, Robert Emmet (Assoc. M. '26; M. 35), Gen. Mgr., Herrera Sugar Co., Potrerillos, Chiriqui, Panama.

Canals, Cesar Socorro (Jun. '27; Assoc. M. '35), Supt., Frederick Snare Corporation, 114 Liberty St., New York, N.Y.

Cant, George Francis, Jr. (Jun. '29; Assoc. M. '35), Civ. Eng., 116 Mowbray St., Kew Gardens, N.Y.

Graham, Nathan Jerome (Jun. '34; Assoc. M. '35), Truck Trail Locator, U. S. Forest Service, 85 Second St., San Francisco (Res., 3046 Sylvan Ave., Oakland), Calif.

Hiles, Robert Eugene (Jun. '26; Assoc. M. '35), Bridge Designer, State Highway Comm. (Res., 2517 Grove Circle, Apartment 9), Little Rock, Ark.

Hormann, Henry Fred (Jun. '30; Assoc. M., '35). Asst. Engr., The New York Edison Co., 4 Irving Pl., New York (Res., 419 Eighty-Fifth St., Brooklyn), N.Y.

Jayne, Stephen Cornelius (Jun. '33; Assoc. M. '35), Res. Engr., State Dept. of Highways, Box 430, Wenatchee, Wash.

Lange, George John Franklin (Jun. '28; Assoc. M. '35), Wire Insp., Golden Gate Bridge and Highway Dist., 75 West St., New York, N.Y. (Res., 176 Central Ave., Leonia, N.J.)

Levy, Edwin Felix (Jun. '27; Assoc. M. '35), Junior Bridge Designing Engr., San Francisco–Oakland Bay Bridge, State Dept. of Public Works, Div. of Highways, 500 Sansome St. (Res., 727 Seventeenth Ave.), San Francisco, Calif.

Lindman, Bertram Herman (Jun. '31; Assoc. M. '35), Eng. Economist, Highway Cost Comm., Care, Dept. of Public Works, Olympia, Wash.

McMahon, Ralph Jennings (Jun. '29; Assoc. M. '35), Technical Asst., State Reclamation Dept. (Res., 202 East 31st St.), Austin, Tex.

Madison, Knowles Knowlton (Jun. '31; Assoc. M. '35), Junior Engr., National Park Service (Res., 322 Van Buren St.), South Haven, Mich.

Mastriani, Samuel Gabriel (Jun. '26; Assoc. M. '35), Cons. Engr., 412 Mears Bldg., Scranton (Res., 1721 Clay Ave., Dunmore), Pa.

Norcross, Theodore White (Assoc. M. '09; M. '35), Chf. Engr., U. S. Forest Service, Room 3111, South Bldg., Washington, D.C.

Pendelton, Julian Brewster (Jun. '28; Assoc. M. '35), Constr. Foreman, Lago Petroleum Corporation, Apartado 172, Maracaibo, Venezuela.

Rucquoi, Léon-Guillaume (Assoc. M. '33; M. '35), Executive Director, Centre Belgo-Luxembourgeois d'Information de l'Acier, 54, Rue des Colonies, Brussels, Belgium.

Schuleen, Ernest Theodore (Jun. '27; Assoc. M. '35), Asst. to Engr., Hydr. Test Dept., Pennsylvania Water & Power Co., Holtwood, Pa.

Snyder, Lester Miles (Jun. '29; Assoc. M. '35), Designer and Job Engr., Standard Oil Co. of California, San Francisco (Res., 2328 Spaulding Ave., Berkeley), Calif.

Stupka, Peter James (Jun. '29; Assoc. M. '35), Traffic Safety Engr., Am. Automobile Assoc. (Res., 2125 G St., N.W., Room 205), Washington, D.C.

Walker, James Donald (Jun. '32; Assoc. M. '35), San. Engr., The Am. Well Works (Res., 419 Main St.), Aurora, Ill.

Winsor, Luther Murkins (Assoc. M., '26; M. '35), Engr., Biological Survey, U. S. Dept. of Agriculture, Box 1314, Minot, N.Dak.

Wood, Walter Jordan (Jun. '27; Assoc. M. '35), Asst. Chf. Hydr. Engr., Los Angeles County Flood Control Dist., 205 South Broadway, Room 521 (Res., 2210 Third Ave.), Los Angeles, Calif.

Reinstatements

Bebbe, John Cleaveland, M., reinstated Nov. 18, 1935.

Blackburn, Dura Albert, Assoc. M., reinstated Nov. 16, 1935.

Craven, John Thomas, Assoc. M., reinstated Nov. 21, 1935.

Fraser, Robert Marshall, Assoc. M., reinstated Nov. 6, 1935.

Jagger, James Edwin, Assoc. M., reinstated Nov. 15, 1935.

Kaminsky, Constantin Denis, Assoc. M., reinstated Nov. 20, 1935.

Love, Andrew Cavitt, M., reinstated Nov. 18, 1935.

Taylor, Bill Northcutt, M., reinstated Nov. 18, 1935.

RESIGNATIONS

Bronson, Joseph Chandler, Assoc. M., resigned Nov. 12, 1935.

Butler, William Tennent, Jr., Jun., resigned Nov. 13, 1935.

Colburn, Burnham Standish, Jr., Jun., resigned Dec. 6, 1935.

Dean, Bertram Dodd, M., resigned Nov. 7, 1935.

Franzen, Charles Siegle, Assoc. M., resigned Dec. 6, 1935.

Harding, Clifford Leon, Jun., resigned Nov. 11, 1935.

LaGrone, Henry Frank, Jun., resigned Nov. 11, 1935.

Leighty, John Ruckle, M., resigned Dec. 4, 1935.

McKay, Donald Middleton, Jun., resigned Dec. 6, 1935.

Malone, James Robert, Jun., resigned Dec. 6, 1935.

Menuez, Edward Arthur, Jun., resigned Nov. 14, 1935.

Rankin, Ardery Robert, Jun., resigned Nov. 12, 1935.

Routh, James Wynbourne, M., resigned Nov. 13, 1935.

Schildhauer, Edward, M., resigned Nov. 11 1935.

Stratton, Robert Hastings, Jr., Jun., resigned Nov. 14, 1935.

Tarbet, Roy Edwin, Jun., resigned Nov. 7, 1935.

Wallace, Aaron Van Duzer, Jr., Assoc. M., resigned Nov. 12, 1935.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

January 1, 1936

NUMBER 1

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Anderson, Alvin George, Minneapolis, Minn. (Age 24.) Refers to F. Bass, A. S. Cutler, L. G. Straub.

Arnold, Emmons Leslie, Pittsburgh, Pa. (Age 34.) Secy. and Treas. and Designing Engr., Pittsburgh Industrial Eng. Co. Refers to F. C. Carstarphen, L. E. Conrad, F. F. Frazier, M. W. Furr, J. Lowery, W. J. Sheldon.

Baker, Charles Duncan, Las Vegas, Nev. (Age 34.) City Engr., Las Vegas, Nev., County Surveyor, Clark County, U. S. Mineral and State Water Right Surveyor, and general civil engineering practice. Refers to H. K. Boone, O. E. Carr, K. L. DeBlois, G. W. Malone, C. Shaw, D. E. Whelan, Jr., W. R. Young.

Batchelder, Charles Leland, St. Paul, Minn. (Age 49.) Dist. Engr., U. S. Geological Survey. Refers to R. W. Davenport, H. M. Hill, J. C. Hoyt, G. E. Loughland, C. G. Paulsen, J. L. Southworth, E. V. Willard.

Becker, Morris, Brooklyn, N.Y. (Age 25.) Eng. Asst., Dept. of Water Supply, Gas & Electricity. Refers to C. T. Schwarze, N. L. Shamroy, D. S. Trowbridge.

Benitez Gautier, Eugenio, Santurce, Puerto Rico. (Age 33.) Supt. of Sewers and Water-Works, FERA of Puerto Rico. Refers to J. Benitez-Gautier, J. M. Bertran, J. V. Davila, M. Font, R. Ramirez, A. S. Romero.

Blum, Albert Elias, Brooklyn, N.Y. (Age 26.) Asst. Engr., Hygrade Constr. Co. Refers to R. C. Brumfield, M. H. Van Buren, J. P. J. Williams.

Broussard, Wilson, Morgan City, La. (Age) 21. Instrumentman, Louisiana Highway Comm. Refers to N. E. Lant, B. W. Pegues, F. F. Pillet.

Bruhn, Alfred Herman, Balboa, Canal Zone. (Age 35.) Supt., Filtration Plant, The Panama Canal. Refers to G. C. Bunker, J. G. Claybourn, W. B. Godfrey, A. L. Hertz, C. B. Hoover, L. B. Moore, E. S. Randolph.

Cartelli, Anthony Raymond, New York City. (Age 22.) Rodman, WPA, Dept. of Parks, on survey of site for World's Fair in Queens. Refers to A. Haring, T. Saville, C. T. Schwarze.

Condron, Arnold Layman, Topeka, Kans. (Age 33.) Asst. Designer, Bridge Dept., State Highway Comm. of Kansas. Refers to T. L. Condron, F. W. Epps, L. Grover, C. S. Heritage, G. S. Knapp, C. L. Post, A. N. Reece.

Corum, William Thomas, Richmond, Calif. (Age 26.) Jun. Administrative Asst., Regional Office, Dept. of Operations, Branch of Improvements, U. S. Dept. of Agriculture, Forest Service. Refers to E. L. Grant, E. R. Huber, J. H. Lawrence, G. McMurtry, C. Moser, L. B. Reynolds, C. L. Young.

Cosenza, Ralph Joseph, Germantown, Philadelphia, Pa. (Age 24.) Refers to H. L. Bowman, S. J. Leonard.

Cranford, Elmo Leavines, Coulee Dam, Wash. (Age 34.) Instrumentman, Class 10, U. S. Bureau of Reclamation. Refers to J. B. Bond, F. W. Hough, L. W. Irwin, R. W. Remp, F. A. Schaak, Jr., O. J. Schieber, N. D. Smith, N. B. Smith.

Dale, Ralph, Minneapolis, Minn. (Age 40.) Associate Highway Engr., U. S. Bureau of Public Roads. Refers to L. J. Charles, L. M. Lawson, W. P. Linton, R. C. Livingston, T. G. MacCarthy, W. J. Titus.

De Fazio, Peter George, Long Branch, N.J. (Age 24.) Rodman, acting as Transitman, Resettlement Administration, Hightstown, N.J. Refers to G. J. Davis, Jr., S. C. Houser.

Dibrell, William Warren, Columbus, Ohio. (Age 43.) Engr. Examiner, FEA of PW (PWA).

Refers to H. M. Boyajohn, H. Christiansen, J. P. Keckler, G. Parker, J. R. Smart, F. E. Swineford.

DUBIN, MILTON, New York City. (Age 21.) Cartographer, Metropolitan Model Project. Refers to F. E. Foss, G. Morrison.

ERSKINE, HARLAN MERCER, Murphy, N.C. (Age 27.) Asst. Hydr. Engr., Water Resources Branch, U. S. Geological Survey. Refers to E. D. Burchard, E. D. Dake, A. S. Fry, N. C. Grover, W. E. Hall, C. E. McCashin, C. G. Paulsen, W. Withee.

GABER, BERNARD, New York City. (Age 42.) Asst. Engr. (Designer), Board of Water Supply. Refers to O. L. Brodie, J. L. Burkholder, H. French, A. Kolberk, W. A. Tyrrell.

HACKETT, PERRY BRADBURY, Hobart, Okla. (Age 23.) Field and Office Engr., Dist. 7A, Oklahoma WPA. Refers to J. F. Brookes, T. E. Wiggins, N. E. Wolfard.

HAGOOD, CHARLES LUKE, Brownwood, Tex. (Age 24.) Jun. Foreman, Soil Conservation Service. Refers to E. A. Burrow, A. F. Moursund, R. Pace, E. E. Pittman, R. J. Potts.

HAYDEN, ROBERT, New York City. (Age 48.) Senior Engr., Navy Yard. Refers to R. W. Boyd, E. J. Moore, A. C. Nichols, J. P. H. Perry, A. C. Tozzer.

HORWITZ, SOLOMON, Jamaica Plain, Mass. (Age 29.) Chf. Engr., West End Iron Works, Cambridge, Mass. Refers to G. H. Brazer, O. H. Horovitz, M. Linenthal, E. A. Norwood, M. A. Reidy.

JACKSON, DUGALD CALEB, Jr., Chicago, Ill. (Age 40.) Prof. and Head, Elec. Eng. Dept., Univ. of Kansas, Lawrence, Kans.; also Director, Lewis Inst. Refers to B. J. Arnold, J. W. Barker, J. G. Bennett, E. Boyce, W. H. Hall, D. C. Jackson, W. B. Jackson, E. J. McCaustland, W. C. McNown, E. L. Moreland, F. A. Russell, F. E. Turneaure.

KELLY, MELVIN CAMPBELL, Snyder, N.Y. (Age 36.) Engr. and Officer, Dist. Improvement Corporation and Great Lakes Concrete Pipe Co., Inc.; also Pres., Northeastern Concrete Pipe Association, all of Buffalo, N.Y. Refers to W. B. Bennett, W. E. Corbett, J. H. Feigel, C. L. Howell, S. S. Neff, R. M. Rumsey, E. J. Sherwood, N. Stone, G. J. Summers.

KENT (formerly KATZELNIK), SYDNEY, New York City. (Age 24.) Refers to R. E. Goodwin, F. O. X. McLoughlin, J. C. Rathbun.

LEE, ROBERT ERNEST, Alvin, Tex. (Age 20.) Rodman, Chainman and Draftsman, Texas Highway Dept. Refers to P. M. Ferguson, J. A. Focht.

MAGNUSON, NELS CONRAD, Austin, Tex. (Age 35.) Hydrographer and Res. Engr., U. S. Geological Survey. Refers to V. L. Austin, S. D. Breeding, C. E. Ellsworth, O. A. Faris, J. A. Norris.

MAMRELLI, EMIL SELEPEGNO, Los Angeles, Calif. (Age 34.) Jun. Civ. Engr., Dept. of Water & Power. Refers to W. W. Hurlbut, D. A. Lane, J. E. Phillips, A. E. Sedgwick, A. L. Sonderegger, H. A. Van Norman.

MARX, CHARLES HENRY, Milwaukee, Wis. (Age 46.) Designer, Water Purification Dept. Refers to M. G. Findley, W. J. Fuller, J. P. Schwada, C. U. Smith, D. W. Townsend, F. W. Ullius, C. S. Whitney.

MEYBURG, GUSTAV, New York City. (Age 27.) Engr. Asst., Dept. of Docks. Refers to H. E. Breed, C. T. Schwarze.

MILLER, ARTHUR LESLIE, Inglewood, Calif. (Age 24.) Draftsman, Metro-Goldwyn Mayer Studios, Culver City, Calif. Refers to R. W. Binder, L. Blog, M. Butler, W. B. James, S. O. Sprager.

NELSON, GEORGE AUGUSTUS, New York City. (Age 41.) Director of Reconditioning, Home Owners' Loan Corporation, Washington, D.C. Refers to J. J. Charters, G. R. Johnson, D. H. McNeal, A. C. Perry, V. B. Phelan, D. H. Sawyer.

NOLEN, JERRY AFTEN, Little Rock, Ark. (Age 22.) Draftsman, Plans & Surveys Dept., Arkansas State Highway Comm. Refers to G. L. Fry, N. B. Garver, W. R. Spencer, W. W. Zass.

PERRY, CLIFTON BENOIT, Ossining, N.Y. (Age 27.) Inventory Asst., Consolidated Gas Company, New York City. Refers to J. F. Halpin, T. R. Lawson.

REIFF, JOHN ROBERT, Portland, Ore. (Age 28.) Jun. Engr., U. S. Engrs. Refers to J. R. Griffith, L. Griswold, A. L. Henny, G. W. Holcomb, R. E. Mackenzie.

ROSICH, MIGUEL RAFAEL, Havana, Cuba. (Age 41.) Cons. Engr. for Riera, Toro & Van Twistern Inc., and member of firm, Mira & Rosich, Engrs. and Archts. Refers to F. M. Aguirre, J. A. Cosculluela y Barreras, C. C. Fitz Gerald, J. J. Manzanilla y Carbonell, N. M. Rivero y Mahy, R. S. Webster, E. R. Williams.

SAX, ALEXANDER, Linden, N.J. (Age 25.) With U. S. Coast & Geodetic Survey, Princeton, N.J. Refers to J. L. Bauer, A. Noack, D. Ramsay, H. R. Stocker, W. M. Van Wagner.

SHADBURN, MORRIS LUTHER, Macon, Ga. (Age 38.) Senior Res. Engr., State Highway Board of Georgia. Refers to J. B. Converse, W. R. Neel, C. C. Newsom, C. L. Rhodes, W. A. Young.

SHELLEY, LEVIE HIGHTOWER, Eufaula, Ala. (Age 33.) Alabama Representative, Eng. Sales and Promotion, Dixie Culvert & Metal Co., Atlanta, Ga. Refers to R. L. Bannerman, C. A. Baughman, J. A. C. Callam, H. H. Houk, G. L. Moulton, M. C. Patton.

SHOEMAKER, WILLIAM SUMMERS, Bethesda, Md. (Age 30.) Engr. with T. Calvin Owens, Gen. Contr. Refers to C. H. Birdseye, O. B. French, C. A. Hoglund, J. R. Lapham, S. S. Steinberg.

SLATTERY, LOUIS ALOYSIUS, New York City. (Age 48.) Secy. and Treas., Lyons-Slattery Co., Inc., Contrs., also Vice Pres. and Gen. Mgr., Hudson River Stone Corporation. Refers to F. W. Allen, W. Caccia, J. H. Myers, R. Ridgway, C. L. Spaulding, C. H. Stengel.

WEBER, JOHN LEROY, Highland Park, N.J. (Age 49.) Pres., John L. Weber, Inc.; also Head of Hydrology Dept., Dept. of Agriculture, Soil Conservation Service, New Brunswick, N.J. Refers to J. N. Brooks, H. T. Critchlow, H. F. Harris, O. W. Hartwell, O. Lauterhahn, E. W. Schoder.

WOOD, ROBERT JULIAN, St. Louis, Mo. (Age 30.) Dist. Engr., American Inst. of Steel Constr. Refers to F. H. Frankland, J. T. Garrett, J. Meltzer, G. Paaswell, J. Singleton.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BAROFSKY, MAX, Assoc. M., Philadelphia, Pa. (Elected April 18, 1927.) (Age 36.) Dist. Engr. in charge of Bridge and Sewer Div., Bureau of Highways, City of Philadelphia. Refers to D. T. Corning, W. E. A. Doherty, J. Firth, E. R. Schofield, C. S. Shaughnessy.

CARLTON, WILLIAM WALTER, Assoc. M., Cincinnati, Ohio. (Elected Jan. 16, 1928.) (Age 37.) Senior Asst. Structural Engr. and Head of Div., Dept. of Bldgs. Refers to H. H. Kranz, F. F. McMinn, F. L. Raschig, E. K. Ruth, W. V. Schmiedeke, C. M. Stegner.

DENNETT, ROBERT CLARK, Assoc. M., New York City. (Elected Assoc. M. June 16, 1919.) (Age 55.) Office Engr., National Board of Fire Underwriters. Refers to C. T. Bissell, G. W. Booth, C. Goldsmith, S. F. Newkirk, Jr., C. A. Pohl, E. E. Seelye.

EVANS, SAMUEL ANTHONY, Assoc. M., Los Angeles, Calif. (Elected March 27, 1933.) (Age 41.) Structural and Hydr. Engr., Dept. of Water & Power. Refers to P. Baumann, O. G. Bowen, R. S. Carberry, W. W. Hurlbut, R. R. Proctor, F. D. Pyle, S. L. Rothery, H. A. Van Norman.

HUNTING, EUGENE NATHAN, Assoc. M., Pittsburgh, Pa. (Elected Junior Nov. 1, 1904; Assoc. M. Apri 11, 1908.) (Age 54.) Member of firm, Hunting, Davis & Dunnells, Engrs., and Archts. Refers to R. A. Cummings, C. G. Dunnells, W. H. Gravell, J. P. Hogan, F. A. Pruitt, C. M. Reppert, N. Schein.

JONES, BENJAMIN EARL, Assoc. M., Washington, D. C. (Elected Junior April 6, 1909; Assoc. M. Dec. 2, 1914.) (Age 52.) Chf., Power Div. (Water and Power Div.), Conservation Branch, U. S. Geological Survey. Refers to R. W. Davenport, N. C. Grover, A. H. Horton, J. C. Hoyt, W. A. Lamb, H. Stabler.

LEGRIS, CHARLES ERNEST, Assoc. M., Worthington, Minn. (Elected Jan. 15, 1923.) (Age 49.) Constr. Engr., Procurement Div., Public Works Branch, U. S. Treasury Dept. Refers to W. N. Collier, F. H. Cothran, M. C. Emanuel, H. S. Gibboney, W. J. Gray, J. A. Holmes, A. C. Lee, D. F. Noyes, W. Oehrle, W. M. Spann.

MICHAELS, ERNEST EDWIN, Assoc. M., Birmingham, Ala. (Elected March 15, 1926.) (Age 38.) Mgr., Birmingham (Ala.) Plant, Chicago Bridge & Iron Works. Refers to H. C. Boardman, A. C. Decker, G. T. Horton, C. S. Pillsbury, M. J. Trees, W. M. Wilson.

MITCHELL, THOMAS JOSEPH, Assoc. M., Washington, D.C. (Elected April 18, 1927.) (Age 47.) Asst. Geodetic Engr., U. S. Coast & Geodetic Survey. Refers to W. Bowie, C. M. Cade, C. O. Carey, C. L. Garner, H. W. Hemple, C. T. Johnston.

OLMSTEAD, CHARLES HAROLD, Assoc. M., LaGrange, Ill. (Elected Nov. 21, 1921.) (Age 44.) Cons. Engr., The Barrett Co., Chicago, Ill. Refers to G. J. Davis, Jr., A. C. Decker, N. W. Dougherty, H. McDonald, J. H. Mayer.

PREGLER, ANTON ANDREW, Assoc. M., Washington, D.C. (Elected Jan. 14, 1924.) (Age 44.) Structural Engr., PWA Housing Div. Refers to F. A. Barnes, W. J. Barney, E. D. Case, E. S. Cole, L. C. Hough, E. E. Seelye, O. Singstad, R. Smillie, L. C. Urquhart, E. Welle, E. K. Wilson.

YOUMANS, GEORGE LELAND, Assoc. M., Blue Island, Ill. (Elected Junior Jan. 7, 1913; Assoc. M. June 11, 1917.) (Age 48.) Dist. Mgr., Morris Knudsen Co., Gen. Contrs., Boise, Idaho. Refers to E. E. Adams, J. Q. Barlow, J. R. W. Davis, C. P. Dunn, F. Mears, R. D. Rader.

FROM THE GRADE OF JUNIOR

BELAEFF, NICHOLAS PLATON, Jun., New York City. (Elected Oct. 30, 1933.) (Age 32.) Field Engr., Madigan & Hyland, Cons. Engrs. Refers to O. P. L. Albert, F. De Schauensee, T. Saville, C. T. Schwarze, E. E. Wissotsky, M. M. Zolotareff.

BELLAMY, EARL DELAINE, Jun., Houston, Tex. (Elected June 10, 1929.) (Age 31.) Asst. Engr. with Harris County, Tex. Refers to C. R. Haile, W. W. McClendon, J. C. McVea, J. M. Nagle, J. H. Rafferty, L. H. Schlom.

BRADLEY, JOSEPH NEWELL, Jun., Denver, Colo. (Elected Jan. 13, 1930.) (Age 32.) Asst. Engr., U. S. Bureau of Reclamation. Refers to E. W. Lane, W. H. Nalder, R. L. Parshall, J. L. Savage, J. E. Warnock.

BROTHERTON, WILLIAM WALLIS, Jun., New York City. (Elected Jan. 16, 1928.) (Age 32.) With Dept. of Civ. Eng., Coll. of City of New York. Refers to E. K. Abberley, L. B. Gallagher, R. E. Goodwin, F. O. X. McLoughlin, G. B. Mebus, H. T. Noyes, R. A. Schmidt, E. H. Schulz, H. H. Snyder.

BURPEE, LAWRENCE HANINGTON, Jun., Beauharnois, Que., Canada. (Elected March 15, 1926.) Res. Engr., Beauharnois Constr. Co. and Beauharnois Light, Heat & Power Co. Refers to A. C. D. Blanchard, F. H. Cothran, G. P.

Hawley, T. H. Hogg, O. O. Lefebvre, D. F. Noyes, D. C. Tennant, C. R. Young.

Egbert, Donald Carlyle, Jun., Birmingham, Mich. (Elected Jan. 13, 1930.) (Age 32.) Bldg. Inspector, also City Assessor and City Representative on County Board. Refers to A. L. Cornell, Jr., H. H. Corson, W. R. Drury, W. C. Hirn, J. B. Jewell, G. H. Kimball, E. H. Pate.

Fairbairn, Edwin Alexander, Jun., Sacramento, Calif. (Elected Oct. 14, 1929.) (Age 31.) Deputy County Engr., Sacramento County. Refers to N. Aanonsen, D. R. Cate, J. W. Gross, I. L. Johnson, R. E. McDonnell, A. G. Proctor, F. D. Talbot.

Harkness, Daniel Hoover, Jun., Lincoln, Nebr. (Elected March 11, 1929.) (Age 32.) Instructor in Civ. Eng., Univ. of Nebraska. Refers to E. R. Cary, C. M. Duff, M. I. Evinger, H. J. Kesner, C. E. Mickey, H. O. Sharp, R. C. Taggart.

Ingram, Temple Byrn, Jun., Olton, Tex. (Elected March 11, 1929.) (Age 29.) Res. Engr. with G. M. Garrett. Refers to G. A. Field, W. H. Garrett, C. S. Henning, Jr., J. T. L. McNew, F. B. Ogle, J. J. Richey, H. N. Roberts.

Lewis, Ralph Webster, Jun., Oak Park, Ill. (Elected April 12, 1926.) (Age 32.) Sales Representative, National Silk Co., Inc., So. Coventry, Conn. Refers to W. M. Bassett, A. Bennett, C. J. Gooch, L. Gurney, G. S. Hewins, T. J. Rouner, E. E. Teeter.

Mickle, David Grant, Jun., Ann. Arbor, Mich. (Elected Nov. 10, 1930.) (Age 27.) With Jensen, Bowen & Farrell, Cons. Engrs.; also Traffic Mgr. with Michigan State Highway Dept. Refers to K. A. Farrell, A. Haertlein, O. V. Jensen, R. L. Morrison, H. E. Riggs.

Packman, Ian Buchanan, Jun., New York City. (Elected March 15, 1926.) (Age 33.) Engr., Pioneer Ice Cream Brands, Inc. Refers to C. A. Pierce, G. E. J. Pistor, H. P. Van Cleve, J. J. Weinrib, A. Weymouth.

Parsons, Gerald Ernest, Jun., Brooklyn, N.Y. (Elected Oct. 10, 1927.) (Age 32.) Asst. Estimator, North-Eastern Constr. Co., New York City. Refers to E. N. Blackwood, J. P. Blundon, R. P. Davis, H. W. Ferris, C. P. Fortney, S. Walker, P. J. Walsh, H. S. Woodward.

Rustan, Arvid Konrad, Jun., Oslo, Norway. (Elected July 16, 1928.) (Age 32.) Supt. of Constr., with Oslo Vann & Kloakvesen. Refers to W. E. Brown, P. L. Hornby, R. Kleppe, P. T. Landsem, E. D. Meyer, W. E. Rudolph.

Sethmann, Martin William, Jun., Brooklyn, N.Y. (Elected May 23, 1932.) (Age 33.) Asst. Engr. of Constr., Dept. of Sanitation, WPA. Refers to H. Fishgrund, H. P. Hammond, C. M. Madden, E. J. Squire, F. W. Stiefel.

Shulits, Samuel, Jun., Denver, Colo. (Elected Oct. 12, 1925.) (Age 33.) Asst. Engr., Canal Sec., U. S. Bureau of Reclamation. Refers to H. Kramer, E. W. Lane, P. S. Reinecke, C. M. Spofford, C. P. P. Vetter, H. D. Vogel.

Torrey, George Armstrong, Jun., Yonkers N.Y. (Elected Oct. 14, 1929.) (Age 31.) Signal Draftsman, Interborough Rapid Transit Co., New York City. Refers to A. H. Beyer, J. K. Finch, F. W. Gardiner, W. J. Krefeld, V. McLean, G. H. Pegram, O. C. Spurling.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1935 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

Construction Engineer and Superintendent; M. Am. Soc. C.E.; age 53; desires position of responsibility; will go anywhere; 30 years experience as superintendent and manager. Hydraulic and dipper dredge work; dock and harbor improvement; irrigation and drainage; roads and heavy excavation. Can do work at low cost. Available on short notice. C-3921.

Construction, Office and Valuation Engineer; Assoc. M. Am. Soc. C.E.; age 40, B.S. in civil engineering; 15 years experience railroad and bridge construction and valuation, railroad location, line and grade revision, bridge, trestle, and culvert construction, and reporting same as required by Interstate Commerce Commission; 11 years in responsible charge. Southeast preferred. D-4034.

Construction, Civil Engineer; Assoc. M. Am. Soc. C.E.; Wisconsin state license; university graduate; 12 years experience on road, bridges, walls, etc., cost reports, surveying, office work, subdivision, supervision, and inspection. Salary or location no object if there is possibility of advancement and some degree of permanency. Available immediately. C-6632.

Construction Engineer and Superintendent; Assoc. M. Am. Soc. C.E.; married; 10 years with contractor on construction of dams, power plants, bridges, pipe lines, buildings, and pavements; 2 years experience on soil erosion control. Desires connection with contracting or engineering firm. Location immaterial. Available short notice. D-1962.

EXECUTIVE

Landscape Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer and land surveyor; 40; 16 years experience one firm in design, construction, operation large-scale land development, including subdivision, cemeteries, race tracks, country clubs, parks, parkways, and park systems. Past experience includes contact with principals and civic bodies. Location, East preferred. Salary, depending on location. B-8019.

Graduate Civil Engineer, 1922; 3 years construction experience; 7 years as engineer in technical department of two cement companies. Duties consisted of consultation to customers, cooperation with engineers and architects on concrete problems, promotion of products, design of mixtures for ready-mix concrete, and office correspondence. C-370.

Sanitary Engineer; Assoc. M. Am. Soc. C.E.; graduate civil engineer; 13 years experience in the design and construction of sewage treatment plants and sewers; in the last two years specializing in chemical-type sewage-treatment plants; will be available on reasonable notice. C-874.

Structural Engineer and Designer; Assoc. M. Am. Soc. C.E.; 42; widower; 20 years experience in details, design, and construction, steel buildings and bridges, also reinforced concrete. Plant layout and design. C.E. graduate. D-1028.

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology, 1908; 25 years experience on design of steel and concrete structures and as resident engineer on construction for iron and steel industry. Thoroughly competent to direct design or to supervise construction in the field. Exceptional references. At present employed. B-5607.

Civil Engineer; M. Am. Soc. C.E.; age 41; now available; civil engineering graduate of Massachusetts Institute of Technology; 11 years experience as foreman, superintendent, construction engineer on sewers, tunnels, subways, harbor work, earthwork, surveys; 3 years stadia; some knowledge of steam and refrigeration. D-4227.

JUNIOR

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E., Massachusetts Institute of Technology, 1933. Majored in structures and sanitation. Experience covers responsible work in topographic and hydrographic surveys, triangulation and adjustment, flood studies and river improvement, also design and supervision of small projects. Available on short notice. D-4484.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 29; married; graduated with highest scholastic average from the School of Technology of the College of the City of New York; excellent recommendations; 1 year surveying experience; 4 years drafting experience, including architectural, structural, and topographical drafting. Desires opportunity; initial salary and location secondary. D-4458.

Recent C.E. Graduate; Jun. Am. Soc. C.E.; some practical construction experience, good draftsman, and structural steel designer. Good personality, excellent recommendations, own car, married, and willing to travel anywhere within U.S. Looking for opportunity offering moderate salary and possibilities of advancement. D-4275.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., North Dakota State College, 1934. Experience: 1 year highway construction, 5 months cadastral surveys. Desires work on highway construction, irrigation, or water conservation. Available two weeks notice. Location immaterial. D-4370-359-A-3, San Francisco.

Civil Engineer; Jun. Am. Soc. C.E.; 23½ years of age; single; B.S. in C.E., University of Pittsburgh, 1934. Worked 8 months as assistant engineer on mapping project. Desires experience and opportunity in any branch of civil engineering. Willing to work. Location immaterial, but Pittsburgh district and vicinity preferred. Available short notice. D-4518.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., 1933. Majored in structural engineering; 1 year experience road construction surveying; 6 months experience drafting and design of large transport; 4 months experience bridge inspection. Desires position. Location immaterial. Available immediately. D-3554.

Civil Engineer; Jun. Am. Soc. C.E.; single; B.S. C.E. 1933. Majored structural steel design and water supply. Experience water and sewage works; geodetic survey. Desires opportunity in any branch civil engineering. Location immaterial. Available on short notice. D-2683.

Civil Engineer; Jun. Am. Soc. C.E.; 26; single; graduate of Sheffield Scientific School, Yale University, 1931, with B.S. cum laude; Sigma Xi; 2 years in building construction; 6 months in responsible charge of work; 6 months engineer precise control survey; 1 year in charge of sanitary sewerage work, construction, survey; some experience in concrete inspection, topographic survey and mapping, making aerial photographs. D-4525.

Recent Graduate; Jun. Am. Soc. C.E.; 23; single; B.S. and C.E. degrees; highest honors; teaching fellow 1 year; limited practical experience; majored in surveys, construction, geology. Desires a start in professional field with moderate salary—will prove ability and value quickly, given opportunity. Will locate anywhere, or travel. Available immediately. D-4515.

Civil Engineer; Jun. Am. Soc. C.E.; 23; married; B.S. and M.S. in C.E., University of Colorado; graduate work in hydraulics and structures; 6 months experience as instructor; 6 months as instrumentman, U. S. Coast and Geodetic Survey; 1 year with the U. S. Bureau of Public Roads. Desires opportunity in any branch of civil engineering, prefers design or construction. Location immaterial. Available immediately. D-4282.

Civil Engineer; Jun. Am. Soc. C.E.; 25; Polytechnic Institute of Brooklyn, 1932; 3 years experience building construction—2 as contractor's engineer in charge engineering work; 1 as assistant engineer on construction 30 state buildings at Orangeburg, Creedmoor, Wingdale, N.Y.; 1 year experience design steel and reinforced concrete structures, buildings, retaining walls, storm water system, etc. Location immaterial. D-2386.

Graduate Civil Engineer; Jun. Am. Soc. C.E., Yale University; 28; single; 4 years experience in all phases of gold lode mining in California, including construction; competent to make mine examinations and operate properties; desires a connection with some soundly financed young mining organization or with some construction firm. C-5760.

Engineer; Jun. Am. Soc. C.E.; A.B., Yale University, 1928; B.S. Sheffield Scientific School, 1930; civil engineer majored in building construction. Layout engineer on reinforced concrete industrial building, state highway department. General surveying 1 year; drafting and designing 2 years; checker of plans, specifications and estimates to present. Desires position with opportunity. D-4318.

Civil Engineer; Jun. Am. Soc. C.E.; single; 23; B.S. in C.E., Georgia School of Technology, 1934; $2^1/_2$ years experience on all types of surveying instruments; 3 months with U. S. Geological Survey on aerial photo-mapping project; 14 months as transitman, U. S. Coast and Geodetic Local Control Surveys. Can handle men. Good knowledge of scientific French. Desires opportunity; initial salary and location secondary. Available short notice. D-4344.

Civil Engineer; Jun. Am. Soc. C.E.; married; age 31. Experience: two years highway, one year structural, one year mining, and one year civil engineering. Education B.S. in civil engineering and graduate study in structural and sanitary engineering. Good references. Location United States or foreign. C-3977.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 28; B.S. in C.E., 1930; over 3 years varied engineering experience, including highway design and construction, sewage disposal plant design, canal surveys, regional planning and mapping, drafting, surveying, chief of survey party, bridge construction. Desires permanent position in any branch of civil engineering. Location immaterial. Available immediately. C-7666.

MISCELLANEOUS

Draftsman; Jun. M. Am. Soc. C.E.; age 28; single; $3^1/_2$ years experience in design and construction of sewers and their appurtenances; 2 years experience in making maps and quantity estimates for river dredging. (Maps made from aerial photographs.) Location and salary secondary. Can give excellent references. Available immediately. D-3919.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 77 of the Year Book for 1935. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

American Planning and Civic Annual. Edited by Harlean James. Washington, D.C., American Planning and Civic Association (Union Trust Building), 1935. 356 pp., photographs, 8 × 5 in., cloth.

This book is a record of recent civic advance, including the proceedings of the conference of city, regional, state, and national planning, held in Cincinnati, Ohio, May 22–25, 1935. It also includes addresses selected from the national conference on state parks, held at Skyland, Va., June 18–21, 1935.

American Sewerage Practice (Vol. III, Disposal of Sewage), 3 ed. By Leonard Metcalf and Harrison P. Eddy. New York and London, The McGraw-Hill Book Company, Inc., 1935. 892 pp., tables, diagrs., charts, 9 × 6 in., cloth, $7.

The developments in the art of sewage treatment during the nineteen years since the publication of the second edition of this volume have been so numerous as to necessitate rewriting a large part of the text. Since the fundamental principles involved in the older methods of treatment underlie the newer processes, an effort has been made to devote adequate space to both groups of processes. Although this treatise is intended primarily to be a survey of American sewerage practice, much information from engineers in England, France, and Germany is included. Some cost data are also given.

Analytical and Applied Mechanics. By G. R. Clements and L. T. Wilson. New York and London, McGraw-Book Co., 1935. 420 pp., diagrs., charts, tables, 9 × 6 in., cloth, $3.75.

This text aims to provide a simple but rigorous discussion of the mathematical theory necessary for a thorough first course in mechanics, and to present a wide variety of applications, interesting in themselves and of direct usefulness to students of engineering. Both graphical and analytical methods are discussed. Many problems are provided.

L'Assainissement des Agglomérations. Vol. 1, L'Évacuation de l'Effluent Urbain. (Encyclopédie Industrielle et Commerciale.) By P. Koch. Paris, Librairie de l'Enseignement Technique, 1935. 375 pp., diagrs., maps, charts, tables, 10 × 7 in., paper, 70 frs.

The first volume of this treatise on municipal sanitation is devoted to the problem of sewerage. The origin of sewage, its composition, sewer systems, and sewer construction and maintenance are discussed comprehensively. The volume emphasizes broad general principles, evaluates the relative importance of various factors, and summarizes present developments, but does not attempt to treat details of present practice. The author is chief of the Seine sanitary district.

Concrete Slabs Reinforced with Welded Wire Fabric. Tested at the University of Delaware under the Direction of T. D. Mylrea, April 25, 1935. Illus., diagrs., charts, 11 × 9 in., paper, apply to Prof. T. D. Mylrea, University of Delaware, Newark, Del.

This report presents the results of a study of the properties of cold-drawn, electrically welded wire fabric and its action when used as reinforcement in concrete slabs. The effect of spot welding upon the strength of the wire, the effect of drooping the fabric upon the strength of the slab, the permissible unit tensile strength, and the influence of the concrete encasement of the structural steel upon the effective length of the span were investigated.

Die Berechnung Verankerter Hängebrücken. By H. H. Bleich. Vienna, Julius Springer, 1935. 101 pp., diagrs., charts, tables, 10 × 7 in., paper, 12 rm.

The author presents a new method for the exact calculation of suspension bridges, which has wide applicability and is easier of application than previous methods. The necessary formulas for nine types of bridges are presented in full. A supplement discusses various special questions of the statics of these bridges.

Earthwork and Retaining Walls. By H. R. Thayer, S. Baker, and A. De Groot. Scranton, Pa., International Textbook Co., 1929. Diagrs., charts, tables, 8 × 5 in., leather, $1.75.

The first section of this volume is on earthwork and describes the methods of excavating and filling used in railroad and highway construction, including the computations necessary. The second section deals with the design and construction of retaining walls. The subjects are treated practically, without the use of higher mathematics.

Military Engineer in India. 2 Vols. By E. W. C. Sandes. Chatham, England, Institution of Royal Engineers, 1935. Illus., maps, 10 × 6 in., cloth, vol. 1, 594 pp., 25s.; vol. 2, 392 pp., 15s. (2 vols. 30s.).

These two volumes deal with the work of military engineers in India from the arrival of the British to the present day. The first volume deals with their military achievements; the second with their civil activities as builders of roads and railroads, buildings and irrigation, water-supply and marine works, as surveyors, archeologists, geologists, and educators, and in other civil capacities.

Mitteilungen aus dem Institut für Baustatik an der Eidg. Technischen Hochschule in Zürich. Mitteilung Nr. 3. Beitrag zur Berechnung der Biegespannungen in Dreieckfachwerken mit und Ohne Hilfssystem. By I. A. el-Demirdash. Zürich and Leipzig, Verlag A. G. Gebrüder Leemann & Co., 1931. 94 pp., diagrs., charts, tables, 9 × 6 in., paper, 6 Swiss francs.

This investigation, carried out at the Zurich Technical High School, is a comparison of the Mohr method of calculating the stresses in rigid frameworks with the exact method. The investigation throws additional light upon the bending stresses in these frameworks.

Recreation Survey of St. Paul, Minnesota, Initiated and Conducted Under the Supervision of the Playgrounds Committee of the St. Paul City Planning Board. By G. H. Herrold. Ed. by K. B. Spear. Research Work Project 62-F2-16, Minnesota Emergency Relief Administration, sponsored by St. Paul City Planning Board, 1934. 214 pp., maps, charts, diagrs., tables, 11 × 9 in., paper, apply.

This report, sponsored by the St. Paul City Planning Board, supplies a comprehensive survey of the recreation facilities provided by public and private agencies. The parks and playgrounds, school and library equipment for recreation, etc., are inventoried.

Steel Dams. By Otis E. Hovey. New York, American Institute of Steel Construction (200 Madison Avenue), 1935. 122 pp., diagrs., charts, tables, photographs, 9 × 6 in., cloth, $2.50.

The purpose of this book is to review a few of the applications of steel to fixed dams and to indicate some of the methods of design and the suitability of steel for such structures. Although steel has been used freely and satisfactorily for movable dams of all types for many years, for about thirty years it has been almost ignored in connection with fixed dams. Long ago, however, a few fixed steel dams were built, and they are still in excellent condition.